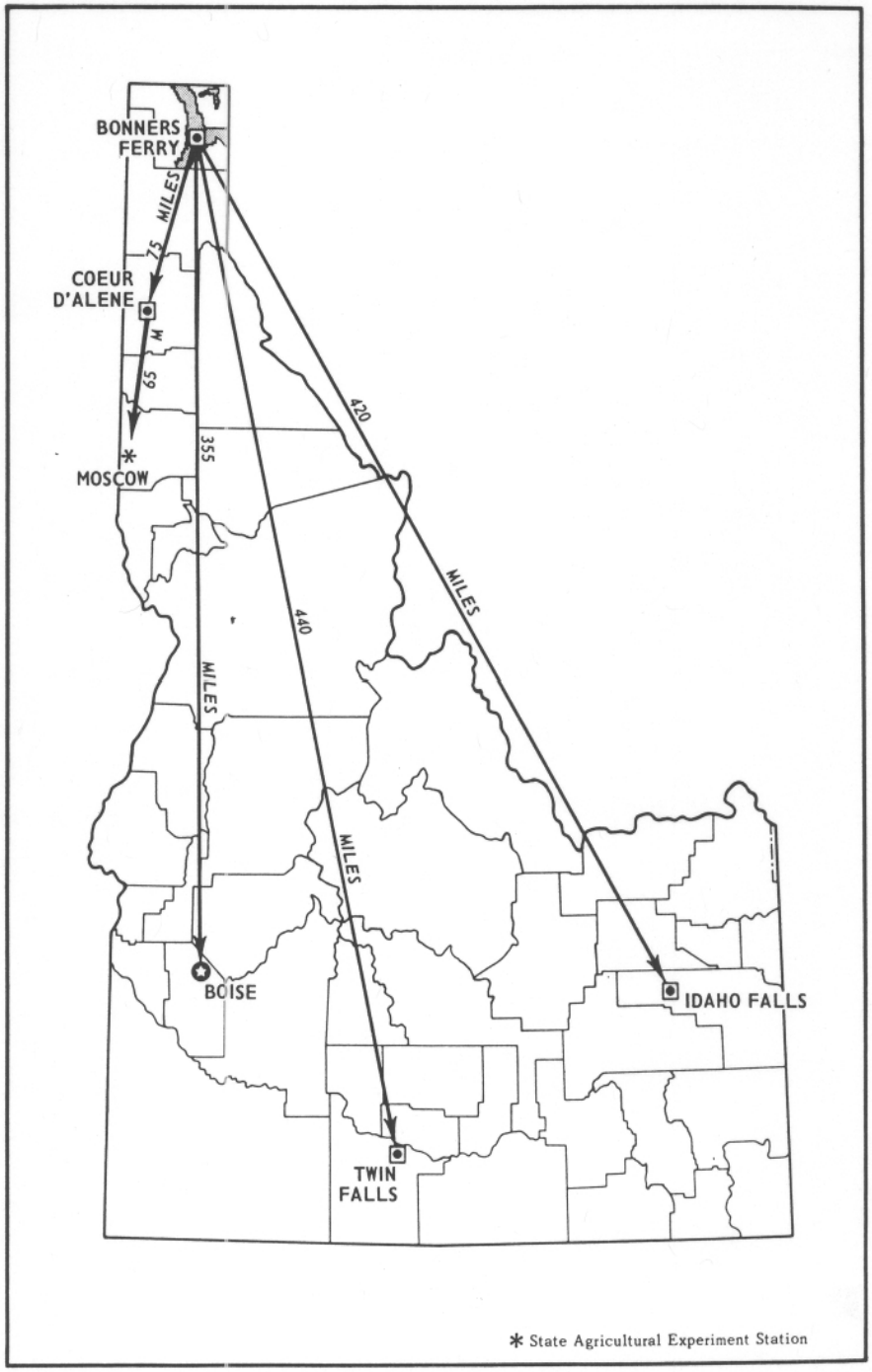

Location of Boundary County Area in Idaho.

SOIL SURVEY OF BOUNDARY COUNTY AREA, IDAHO

By Jack C. Chugg and Maynard A. Fosberg

United States Department of Agriculture, Soil Conservation Service, and United States Department of the Interior, Bureau of Indian Affairs, in cooperation with the University of Idaho College of Agriculture, the Idaho Agricultural Experiment Station, the Boundary Soil Conservation District, and Boundary County

THE BOUNDARY COUNTY AREA is in the northernmost part of Idaho (see facing page). It has a total of about 192,000 acres, or 295 square mines. The natural vegetation was conifer forest on the terraces and a water-tolerant plant cover on the Kootenai River flood plain.

The Area is bounded on the north by British Columbia, Canada; on the east by the Kaniksu National Forest and Montana; on the south by Bonner County, Idaho; and on the west by the Kaniksu National Forest. Included in the survey area is about 12,160 acres of private land within the national forest in the Round Prairie Creek and Moyie River area. About 1,000 acres is under the Idaho Department of Fish and Game, about 2,800 acres under the Bureau of Sport Fisheries and Wildlife, about 6,000 acres under the Bureau of Land Management, and about 2,500 acres under the Bureau of Indian Affairs.

The survey does not include all the private county and State lands in Boundary County. It includes only the acreages that have the most potential for changes in land use.

The survey area is generally confined to the major valley systems of Boundary County. It consists of the Kootenai River flood plain, the high terraces above the Kootenai River and Deep Creek, the terraces, moraines, and fans along Round Prairie Creek and the Moyie River, and the hills and valleys in the Curley Creek-Buckhorn area.

The Kootenai River flows northwestward through a canyon to the mouth of the Moyie River, then westward, on to a broad, nearly level flood plain to the Purcell trench, and then along the trench northward to the International boundary between Canada and United States. The flood plain is about 1/2 to 3 miles wide. The elevation ranges from 1,755 to 1,800 feet. The Purcell trench separates the Selkirk Mountains to the west, the Cabinet Mountains to the southeast, and the Purcell Mountains to the northeast. The trench is a broad U-shaped valley that was scoured by great lobes of ice during the Pleistocene age. The Kootenai River and Deep Creek occupy the trench. Tributary valleys to the Kootenai River were glaciated. The Purcell trench and some tributaries to the Kootenai River in the Curley Creek area near the Montana boundary were filled by lacustrine sediments associated with glacial Lake Kootenai. Remnants of these sediments formed high terraces and are partially dissected by streams entering the flood plain on all sides. The elevation is about 2,000 feet near Porthill to 2,500 feet at the margins of the valley. The highest elevation in the Area is about 4,000 feet in the 20-mile Creek drainageway in the southeastern part of the survey area.

Most of the Area was forested, except for the Kootenai River flood plain, which had a marsh-type vegetation consisting of scattered trees and brush on the higher parts of the landscape. The land is now in farms and was reclaimed by the development of drainage districts and a system of dikes to minimize spring flooding and to drain surplus water. About 35,000 acres is farmed in the flood plain, of which about 450 acres is irrigated. About 95,516 acres is farmed on the terraces in Pleasant and Paradise valleys, Kootenai orchard, and the Highland, Porthill, Dear Park, and North Bench areas. There are some farms or ranches east of the Moyie River and in the Round Prairie Creek and Addy areas.

The principal enterprises in the survey area are forest products, farming, and livestock. Recreation, mostly for tourists from Canada and other parts of the United States, is also an important source of income. There are about 308 farms in the Area.

The State Wildlife Management area at McArthur Lake, as well as other numerous streams and lakes, attract fishermen to the Area. The Kootenai National Wildlife Refuge west of the City of Bonners Ferry attracts waterfowl enthusiasts.

The population of the Area is about 8,100. The highest population is in the valleys, mainly in the towns and villages. Bonners Ferry, the county seat and the largest town in the Area, has a population of about 3,300 (9). The population of Moyie Springs is 203.

Because of difference in slope, aspect, natural vegetation, and parent material, the soils vary greatly throughout the survey area. Some soils are best suited to trees. Others are suited to trees and cultivated crops.

The principal crops grown are spring wheat, winter wheat, oats, barley, alfalfa, clover seed, pasture, and a small acreage of irrigated hops.

The trees most commonly grown for wood products are grand fir, Douglas-fir, and western larch. Western white pine, lodgepole pine, western redcedar, western hemlock, and ponderosa pine are also important. Much of the wood is processed in local sawmills at Bonners Ferry, Moyie Springs, and Naples.

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Italicized numbers in parentheses refer to Literature Cited, page 69.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Boundary County Area, where they are located, and how they can be used. The soil scientists went into the survey area knowing they likely would find many soils they had already seen, and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent; material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied and compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according; to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where it was first observed and mapped. Porthill and Ritz, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Porthill silt loam is a phase within the Porthill series.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils or groups of soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this survey was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units, soil complexes and soil associations, are shown on the soil map of the Boundary County Area.

A soil complex consists of areas of two or more soils so intricately mixed or so small in size that it is impractical to map them separately. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Ritz-Schnoorson complex is an example.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, joined by a hyphen. DeVoignes-Ritz association is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rock outcrop-Pend Oreille-Kriest complex is an example of a land type in a complex with two soil series.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements to help in classifying the soil and making interpretations. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the cultivated soils.

Soil scientists observe how soils behave when used as a growing medium for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this failure to slow permeability or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a given kind of soil, and they relate this failure to a high shrink-swell potential. Thus, they use observation and knowledge of soil properties, together with available research data, to predict the limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their study and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a dis-

tinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments, and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The six soil associations in this survey area are described on the pages that follow.

1. Schnoorson-Ritz-Farnhamton association

Level to gently sloping, moderately well drained and poorly drained, very deep silty clay loams, silt loams, and mucky silt loams in basins and swales and on low terraces and natural levees; on flood plains

This association is along the Kootenai River (fig. 1) and on broad stream bottoms of Round Prairie Creek, the Moyie River, Deep Creek, and Curley Creek. The soils formed in mixed alluvium. The vegetation on the mineral soils is shrubs, grasses, and deciduous trees. The vegetation on the organic soils is dominated by sedges, rushes, cattails, and trees. Elevation ranges from 1,750 to 2,700 feet. Mean annual precipitation is 20 to 24 inches. Mean annual soil temperature is 45 to 47°F., and the frost-free season ranges from 120 to 140 days.

This association makes up approximately 27 percent of the survey area. It is about 27 percent Schnoorson soils, 25 percent Ritz soils, 12 percent Farnhamton soils, 10 percent DeVoignes soils, and 26 percent Pywell, Bane, and Seelovers soils and water areas.

The level Schnoorson soils are in basins or depressions and swales of the ridge-swale complex. Typically, the surface layer is light brownish gray silty clay loam about 6 inches thick. The substratum to a depth of 40 inches is light gray silty clay loam. Below this, to a depth of 60 inches, it is light gray silty clay. These soils have distinct and prominent mottles below the surface layer. They are calcareous in the upper part of the profile.

The nearly level Ritz soils are on low terraces and ridges. Typically, the surface layer is light brownish gray silt loam 8 inches thick. The substratum to a depth of 46 inches is mottled, light gray silt loam. Below this, to a depth of 60 inches, it is light gray silt loam that is thinly stratified with very fine sandy loam. These soils have distinct and prominent mottles below the surface layer. They are calcareous throughout the profile.

The gently sloping Farnhamton soils are on natural levees on flood plains along the river and its tributaries. Typically, the surface layer is light brownish gray silt loam about 7 inches thick. The upper 15 inches of the substratum is light brownish gray silt loam. The lower part to a depth of 60 inches is light gray and grayish brown silt loam.

The level DeVoignes soils are in basins and depressions in the flood plains. Typically, the surface layer is light gray mucky silt loam about 9 inches thick. The upper 15 inches of the substratum is alternate thin layers of dark gray muck and light gray silty clay loam. The lower part to a depth of 65 inches is light gray silty clay loam. The lower part to a depth of 65 inches is light gray silty clay loam and silty clay. Reaction is neutral to medium acid to a depth of 24 inches and neutral and mildly alkaline below.

This association is used mainly for dryland crops. Most of it is protected from flooding by dikes. Drainage ditches and pumps control the level of the water table during the growing season.

2. Rubson-Porthill association

Nearly level to sloping, well drained and moderately well drained, very deep silt loams on high terraces

This association is on high terraces (fig. 2) above the Kootenai River flood plain. These soils formed in mixed alluvium derived from glaciolacustrine sediments. The vegetation is mostly conifers. Elevation ranges from 2,000 to 2,700 feet. Mean annual precipitation is 20 to 28 inches. Mean annual soil temperature is 41 to 45°F., and the frost-free season ranges from 110 to 140 days.

This association makes up approximately 21 percent of the survey area. It is about 67 percent Rubson soils, 28 percent Porthill soils, and 5 percent Selle and Elmira soils.

The nearly level to gently rolling Rubson soils are generally on high terraces in the central and southern part of the survey area. Typically, the surface layer is pale brown silt loam about 14 inches thick. Next, to a depth of 29 inches, is very pale brown and light gray silt loam. Below this, to a depth of 55 inches, is very pale brown and light gray silt loam. Below this, to a depth of 55 inches, is reddish yellow, light gray, and brown silt loam and very fine sandy loam. The substratum to a depth of 68 inches is a light gray loamy very fine sand. Reaction is slightly acid and medium acid to a depth of 55 inches and mildly alkaline below.

The nearly level to moderately steep Porthill soils are generally on high terraces in the northern part of the survey area. The surface layer is pale brown silt loam about 13 inches thick. The subsoil is light gray heavy silty clay loam and silt loam about 19 inches thick. The substratum to a depth of 60 inches is strongly calcareous, light olive gray and light gray silty clay loam and silt loam. Reaction is slightly acid to neutral in the surface layer and upper part of the subsoil, mildly alkaline in the lower part of the subsoil, and moderately alkaline in the substratum.

Most of this association is used for dryland crops. About 200 acres is used for irrigated Bavarian hops.

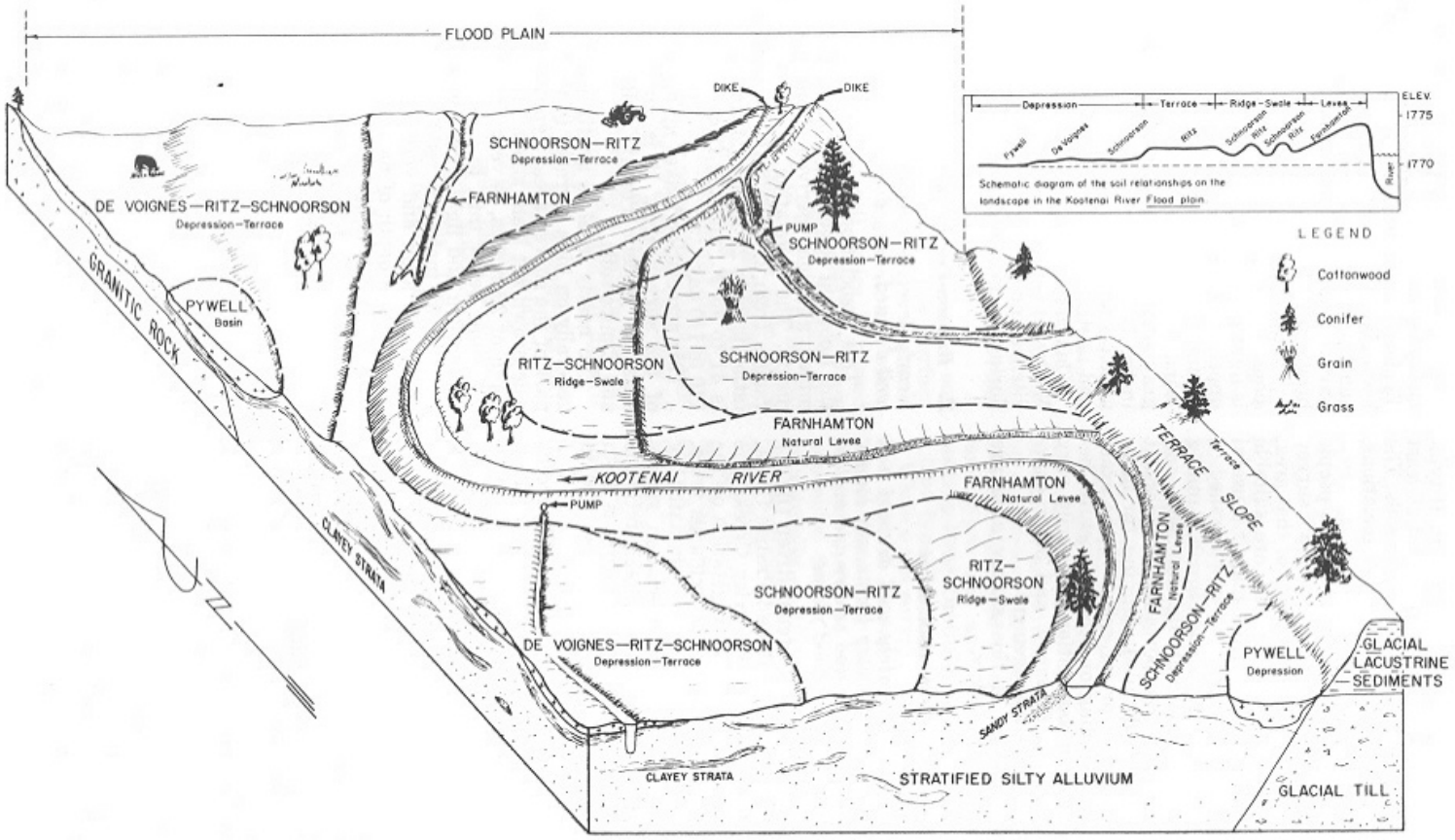

***Figure 1.*—Typical pattern of soils in association 1.**

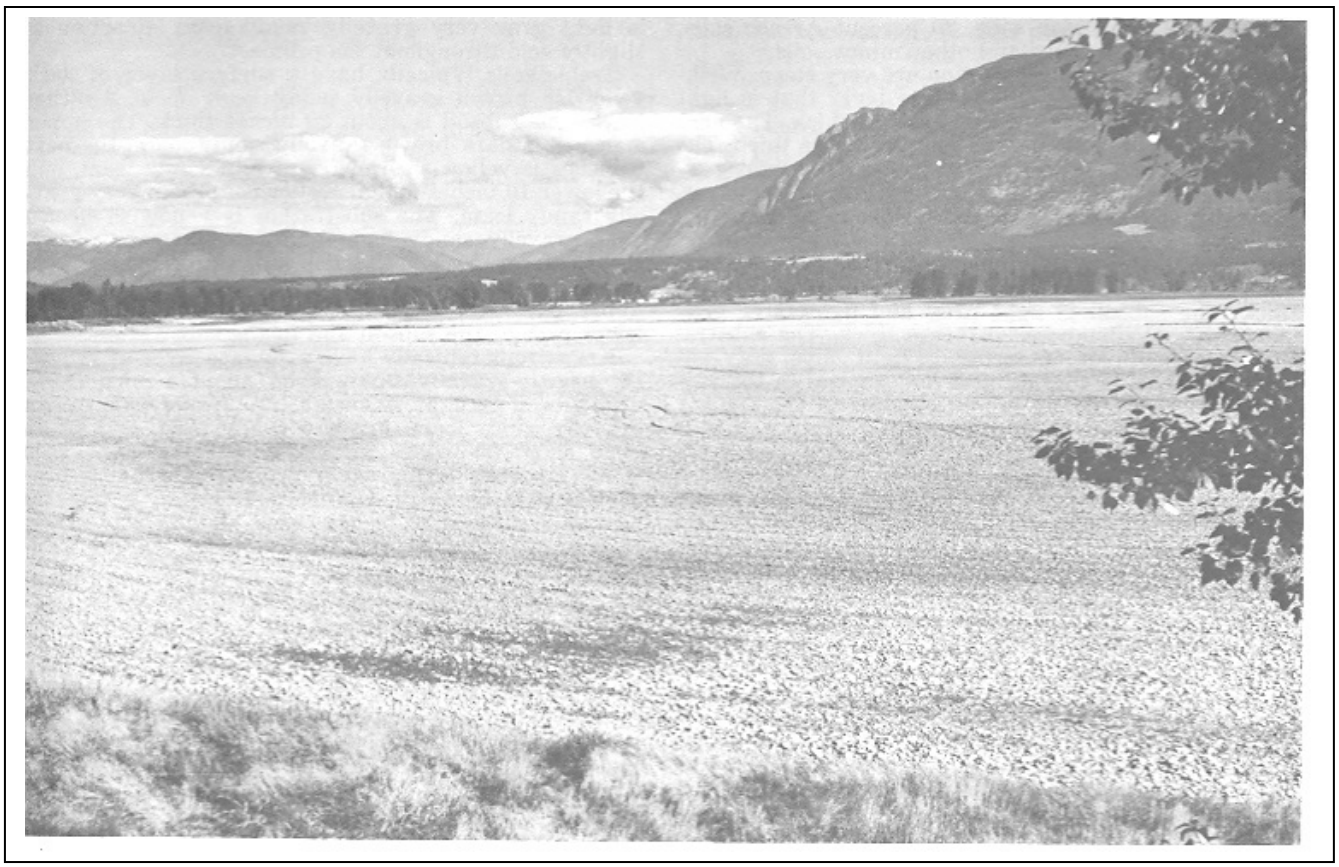

Figure 2.-Typical landforms in survey area. Schnoorson-Ritz-Farnhamton association in foreground, Wishbone-Crash association on terraces, Rubson-Porthill association on high terraces, and Pend Oreille-Rock outcrop association on mountainsides.

3. Selle-Elmira association

Nearly level to hilly or duny, well drained and excessively drained, very deep fine sandy loams and loamy sands on high terraces

This association is on high glaciolacustrine terraces above the Kootenai River near Bonners Ferry. It extends from Naples to McArthur Lake in the southern part of the survey area. The vegetation is mostly conifers. Elevation ranges from 2,000 to 2,500 feet. Mean annual precipitation is 23 to 28 inches. Mean annual soil temperature is 43 to 47°F., and the frost-free season ranges from 110 to 140 days.

This association makes up approximately 3 percent of the survey area. It is about 75 percent Selle soils, 22 percent Elmira soils, and 3 percent Rubson soils.

The nearly level to gently sloping, undulating, or duny Selle soils are on sandy terraces. Typically, the surface layer is brown and light yellowish brown fine sandy loam about 15 inches thick. The subsoil is brown and yellowish brown loamy fine sand and sand about 25 inches thick. The substratum to a depth of 60 inches is pale brown sand. Reaction is medium acid in the surface layer, slightly acid and neutral in the subsoil, and neutral in the substratum.

The nearly level to hilly or duny Elmira soils are also on sandy terraces. Typically, the surface layer is yellowish brown loamy sand about 4 inches thick. The subsoil is light yellowish brown loamy sand and pale brown fine sand about 20 inches thick. The substratum to a depth of 60 inches is light gray fine sand. Reaction is medium acid in the surface layer and slightly acid in the subsoil and substratum.

Most of this association is used for woodland, wildlife, and recreation. Broad areas of Selle soils are used for dryland crops.

4. Wishbone-Crash association

Very steep, well drained and moderately well drained, very deep silt loams on terraces

This association is on terraces (see figure 2) above the Kootenai River flood plain and along Deep Creek. The vegetation has very complex patterns of conifers. Elevation ranges from 1,800 to 2,200 feet. Mean annual precipitation is 20 to 24 inches. Mean annual soil temperature is 40 to 49°F., and the frost-free season ranges from 80 to 140 days.

The association makes up approximately 13 percent of the survey area. It is about 35 percent Wishbone

soils, 32 percent Crash soils, 20 percent Artnoc soils, and 13 percent Caboose and other minor soils.

All the soils in this association are very steep. Wishbone soils typically have a surface layer that is light brownish gray silt loam about 5 inches thick. The next layer is light gray silt loam about 13 inches thick. The subsoil extends to a depth of 60 inches. It is light gray silt loam. The soil is slightly acid in the surface layer, neutral in the next layer, and mildly alkaline in the subsoil.

Typically, Crash soils have a surface layer that is light gray and light olive gray silt loam about 7 inches thick. The subsoil is light gray and light olive gray silt loam and silt about 20 inches thick. The substratum to a depth of 60 inches is light olive gray silt loam. Reaction is slightly acid and neutral in the surface layer, neutral and mildly alkaline in the subsoil, and mildly alkaline in the substratum. Depth to lime is 27 inches. Artnoc soils typically have a surface layer that is light gray silt loam about 6 inches thick. The subsoil is light brownish gray silt loam about 25 inches thick. The substratum to a depth of 60 inches is light olive gray silt loam. Reaction is medium in the surface layer, slightly acid in the subsoil, and neutral in the substratum.

This association is used for woodland, wildlife habitat, and recreation.

5. Pend Oreille-Rock outcrop association

Sloping to very steep, well drained, deep and very deep gravelly sandy loams, sandy loams, and silt loams and rock outcrop on glaciated mountainsides

This soil association is on glaciated mountainsides (see figure 2, page 5). The soils formed in a thin mantle of volcanic ash and the underlying glacial till. Rock outcrop is common. Because of extreme variation of aspect, the vegetation has a very complex pattern. Elevation ranges from 1,800 to 4,400 feet. Mean annual precipitation is 20 to 30 inches. Mean annual soil temperature is 41 to 46°F., and the frost-free season ranges from 70 to 130 days.

The association makes up approximately 25 percent of the survey area. It is about 31 percent Pend Oreille soils, 26 percent Rock outcrop, 18 percent Idamont soils, 16 percent Treble soils, 6 percent Kriest soils, and 3 percent water and minor soils.

Pend Oreille soils typically have a surface layer of brown sandy loam about 4 inches thick. The upper part of the subsoil is yellowish brown sandy loam about 10 inches thick. The lower part of the subsoil is light yellowish brown gravelly and cobbly sandy loam about 13 inches thick. The substratum to a depth of 60 inches is pale brown cobbly loamy coarse sand. Reaction is slightly acid to a depth of 27 inches and neutral below.

Rock outcrop consists mainly of steep to very steep exposures of barren rock.

Idamont soils typically have a surface layer of pale brown silt loam about 7 inches thick. The upper part of the subsoil is light yellowish brown and very pale brown silt loam about 21 inches thick. The lower part of the subsoil is pale brown gravelly sandy loam about 24 inches thick. The substratum to a depth of 60 inches is light gray very gravelly sandy loam. Reaction is slightly acid throughout the profile.

Treble soils typically have a surface layer of dark yellowish brown gravelly sandy loam about 2 inches thick. The subsoil is about 20 inches thick. The upper 4 inches is dark brown gravelly sandy loam, the next 6 inches is yellowish brown gravelly sandy loam, and the lower 10 inches is light yellowish brown very gravelly sandy loam. The substratum is yellowish brown very gravelly sandy loam and gravelly sandy loam. Weathered bedrock is at a depth of 42 inches. Reaction is neutral in the surface layer, slightly acid in the upper part of the subsoil, and medium acid in the lower part of the subsoil and in the substratum.

Kriest soils typically have a surface layer of yellowish brown gravelly sandy loam about 1 inch thick. The subsoil is light yellowish brown and pale brown gravelly sandy loam, gravelly loamy sand, and sandy loam about 30 inches thick. The substratum is pale brown gravelly loamy sand. Weathered granitic bedrock is at a depth of 41 inches. Reaction is medium acid to a depth of 16 inches and is slightly acid below.

This association is used for woodland, wildlife habitat, and recreation.

6. Stien-Pend Oreille association

Nearly level to moderately steep, well drained, very deep gravelly silt loams and sandy loams on moraines in valleys and on glaciated mountainsides

This soil association is on glacial recessional moraines in valleys and on glaciated mountainsides along Round Prairie Creek and in the Moyie River Valley. The soils formed in a thin mantle of volcanic ash and the underlying glacial drift. The vegetation is mostly conifers. Elevation ranges from 2,200 to 3,600 feet. Mean annual precipitation is 25 to 30 inches. Mean annual soil temperature is 41 to 45°F., and the frost-free season ranges from 90 to 110 days.

This association makes up approximately 6 percent of the survey area. It is about 79 percent Stien soils, 15 percent Pend Oreille soils, and 6 percent water and minor soils.

The nearly level to sloping Stien soils are on glacial moraines. Typically, the surface layer is light yellowish brown gravelly silt loam about 4 inches thick. The subsoil is about 21 inches thick. It is light yellowish brown very gravelly silt loam in the upper part and very pale brown very cobbly sandy loam in the lower part. The substratum to a depth of 60 inches is very pale brown very gravelly coarse sand. Reaction is slightly acid throughout the profile.

The sloping to moderately steep Pend Oreille soils are on glaciated mountainsides. Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 10 inches of the subsoil is yellowish brown sandy loam. The lower 13 inches is light yellowish brown gravelly and cobbly sandy loam. The substratum to a depth of 60 inches is pale brown cobbly loamy coarse sand. Reaction is slightly acid to a depth of 27 inches and is neutral below.

Most of this association is used for woodland, wildlife habitat, and recreation. Small areas have been cleared for pasture and hay crops.

Descriptions of the Soils

In this section the soil series and mapping units in the Boundary County Area are described. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for a mapping unit in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile. The soil profile is the sequence of layers from the surface downward to rack or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Rock outcrop, for example, does not belong to a soil series, but nevertheless, is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the soil map. Listed at the end of each description of a mapping unit is the capability subclass or unit, the woodland group, and the wildlife group to which the mapping unit has been assigned. The page for the description of each capability unit, woodland group, and wildlife group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (6).

Artnoc Series

The Artnoc series consists of moderately well drained soils on terraces. These soils formed in silty, calcareous glaciolacustrine sediment. Slopes are 45 to 75 percent. The vegetation is western redcedar, grand fir, western white pine, and Myrtle pachistima. Elevation is 1,800 to 2,700 feet. Precipitation is 21 to 24 inches. Mean annual soil temperature is 41 to 43°F., and the frost-free season is 90 to 120 days.

In a representative profile the surface layer is light gray silt loam about 6 inches thick. The subsoil, about 25 inches thick, is light brownish gray silt loam that has thin discontinuous yellowish brown bands. The substratum to a depth of 60 inches is light olive gray silt loam. Reaction is medium acid in the surface layer, slightly acid in the subsoil, and neutral in the substratum.

Permeability is moderately slow. The soil is more than 60 inches deep and holds 11 to 13 inches of water available to plants.

These soils are used for woodland, wildlife habitat, and recreation.

The Artnoc soils in this survey area are mapped only with Crash soils.

Representative profile of Artnoc soil in an area of

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

Crash-Artnoc complex, about 2,000 feet south and 1,500 feet west of the northeast corner of sec. 1, T. 60 N., R. 1 W. on an easterly slope of 55 percent:

O11-2 inches to 0.5 inch; needles and twigs.

O12-0.5 inch to 0 ; partly decomposed needles and twigs.

A21-0 to 2 inches; light gray (2.5Y 7/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure ; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots ; many very fine and fine pores; medium acid; clear wavy boundary.

A22-2 to 6 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; weak fine subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots ; many very fine and fine pores ; many very fine and fine black concretions; medium acid; clear wavy boundary.

B2t-6 to 16 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots ; many very fine and fine pores; 25 to 50 percent of the horizon is yellowish brown bands that are 1/16 inch to 2 inches thick and about 10 percent more clay than the matrix; many very fine, fine, and medium black concretions; slightly acid; gradual boundary.

B3t-16 to 31 inches ; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots; many very fine and fine pores; 10 to 20 percent of the horizon has dark yellowish brown bands 1/16 to 1 inch thick that are about 10 percent more clay than the matrix; many very fine, fine, and medium black concretions; slightly acid; gradual wavy boundary.

C-31 to 60 inches; light olive gray (5Y 6/2) silt loam, olive gray (5Y 5/2) moist; laminated glaciolacustrine sediments; neutral.

The A2 horizon has hue of 10YR or 2.5Y and value of 6 or 7 dry and 4, 5, or 6 moist. The B horizon has hue of 2.5Y and 5Y and value of 6 or 7 dry and 4 to 6 moist. It is weak subangular blocky or prismatic. Yellowish brown or dark yellowish brown, wavy, discontinuous bands occupy 10 to 80 percent of the matrix. The bands are 1/16 inch to 3 inches thick, and the clay content is 12 to 16 percent more than in the matrix. Depth to the C horizon is 30 to 72 inches.

Bane Series

The Bane series consists of excessively drained soils on alluvial fans at the mouth of steep canyons. These soils formed in granitic alluvium. Slopes are 2 to 8 percent. The vegetation is ponderosa pine, Douglas-fir, black cottonwood, and pinegrass. Elevation is 1,750 to 2,000 feet. Precipitation is 20 to 25 inches. Mean annual soil temperature is 44 to 46°F., and the frost-free season is 90 to 110 days.

In a representative profile the surface layer is very dark gray loamy fine sand about 5 inches thick. The upper 33 inches of the substratum is stratified white gravelly sand and fine sand. The lower part to a depth of 60 inches is grayish brown gravelly loamy fine sand and very gravelly sand. Reaction is neutral throughout the profile.

Permeability is rapid. The soil is more than 60 inches deep and holds 3 to 5 inches of water available to plants.

These soils are used for woodland and pasture.

Representative profile of Bane loamy fine sand 1,700 feet north and 800 feet east of the southwest corner of sec. 24, T. 62 N., R. 1 W.

O1-1 inch to 0 ; needles, twigs, leaves, and grass.

A1-0 to 5 inches; very dark gray (10YR 3/1) loamy fine sand, black (10YR 2/1) moist; weak fine granular structure; soft, very friable, slightly sticky; many very fine, fine, medium, and coarse roots, many pores; 5 percent fine gravel ; neutral ; clear wavy boundary.

C1-5 to 24 inches; white (10YR 8/2) gravelly sand, light brownish gray (10YR 6/2) moist; single grained; loose; few fine, medium, and coarse roots; many pores; 35 percent gravel; neutral ; abrupt wavy boundary.

IIC2-24 to 38 inches; white (10YR 8/2) fine sand, grayish brown (10YR 5/2) moist; single grained; loose; few roots; 10 percent gravel; neutral; abrupt wavy boundary.

IIIA1b-38 to 42 inches; grayish brown (10YR 5/2) gravelly loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, slightly sticky; few roots ; 20 percent gravel ; neutral; clear wavy boundary.

IVC3-42 to 60 inches; grayish brown (10YR 5/2) very gravelly sand, dark grayish brown (10YR 4/2) moist; single grained; loose; 60 to 90 percent gravel; neutral.

Between depths of 10 to 40 inches is stratified sand that is 10 to 40 percent rock fragments. Buried A1horizons do not occur in some pedons. The A1 horizon has value of 3 to 4 dry and 2 or 3 moist and chroma of 1 or 2. Reaction is neutral or slightly acid.

BA-Bane loamy fine sand. This soil is on recent alluvial fans at the mouths of canyons along the west side of the Kootenai River flood plains. Slopes are 2 to 8 percent. About 5 percent of the mapping unit is included areas of Farnhamton soils, and about 10 percent is areas of scattered boulders at the heads of alluvial fans. The stream channel is subject to change as a result of channel plugging by debris during spring runoff.

This soil is used for woodland, farmsteads, and pasture. Capability subclass VIs; woodland group 1s6; wildlife group 3343.

Caboose Series

The Caboose series consists of well drained soils on terraces. These soils formed in glaciolacustrine sediment. Slopes range from 45 to 75 percent. The vegetation is grand fir, Douglas-fir, ponderosa pine, and Myrtle pachistima. Elevation is 1,800 to 2,000 feet. Precipitation is 20 to 24 inches. Mean annual soil temperature is 45 to 47°F., and the frost-free season is 100 to 130 days.

In a representative profile the surface layer is light brownish gray very fine sandy loam about 8 inches thick. The subsoil is about 48 inches thick, The upper 26 inches is light brownish gray very fine sandy loam and silt loam that has many thin bands of dark yellowish brown. The lower 22 inches is pale olive silt loam that has many thin bands of pale brown. The substratum to a depth of 60 inches is light olive brown, moderately calcareous very fine sandy loam. Reaction is slightly acid in the surface layer, neutral in the subsoil, and mildly alkaline in the substratum.

Permeability is moderate. The soil is more than 60 inches deep and holds 9 to 13 inches of water available to plants.

These soils are used for woodland, wildlife habitat, and recreation.

The Caboose soils in this area are mapped only with Wishbone soils.

Representative profile of Caboose very fine sandy loam in an area of Crash-Artnoc complex about the center of sec. 9, T. 61 N., R. 1 E., on a southeast-facing slope of 58 percent:

O1-1 to 1/2 inch; needles, twigs, and grass.

O12-1/2 inch to 0 ; partly decomposed needles, twigs, and grass.

A21-0 to 4 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak very fine and fine granular structure; hard, friable, slightly sticky and slightly plastic ; many very fine to coarse roots; many very fine and fine pores and few medium pores; slightly acid; clear smooth boundary.

A22-4 to 8 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine to coarse roots; many very fine to medium pores; many very fine faint black concretions; slightly acid; clear wavy boundary.

B1-8 to 20 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine to coarse roots ; many very fine and few medium pores; many very fine and fine faint black concretions ; 50 to 70 percent of the horizon is dark yellowish brown bands that are lib to 3 inches thick and about 10 percent more clay than matrix; neutral; clear wavy boundary.

B2t-20 to 34 inches; light brownish gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; moderate medium subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; common very fine to coarse roots; many very fine and few medium pores; many very fine and fine black concretions ; 50 to 70 percent of the horizon is dark yellowish brown bands that are 1/16 inch to 3 inches thick and about 10 percent more clay than the matrix; neutral; clear wavy boundary.

B3t-34 to 56 inches; pale olive (5Y 6/3) silt loam, olive brown (2.5Y 4/4) moist; weak coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few medium and fine roots ; common very fine pores; 10 to 25 percent horizon is pale brown bands that are 1/16 inch to 2 inches thick and about 10 percent more clay than the matrix; many very fine and fine faint black concretions; neutral; abrupt wavy boundary.

C-56 to 60 inches; light olive brown (2.5Y 5/4) very fine sandy loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; moderately calcareous ; mildly alkaline.

Some undisturbed areas have a thin discontinuous light gray layer of volcanic ash between the organic and mineral layers. The A2 horizon has hue of 2.5Y or 10YR, value of 5 to 7 dry and 4 or 5 moist, and chroma of 2 or 3. It is slightly acid or medium acid. Base saturation is 60 percent. The B2t horizon has hue of 2.5Y or 5Y, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 or 4 in the lower part. It is slightly acid or neutral.

Crash Series

The Crash series consists of moderately well drained soils on terraces. These soils formed in silty glaciolaucustrine sediment. Slopes are 45 to 75 percent. The vegetation is western hemlock, western redcedar, grand fir, and Myrtle pachistima. Elevation is 1,800 to 2,700 feet. Mean annual precipitation is 21 to 24 inches. Mean annual soil temperature is 40 to 43°F., and the frost-free season ranges from 80 to 110 days.

In a representative profile the surface layer is light gray and light olive gray silt loam about 7 inches thick. The subsoil is about 20 inches thick. It is light gray and light olive gray silt loam and silt that has many very thin bands of dark yellowish brown. The substratum to a depth of 60 inches is strongly calcareous, light olive gray silt loam. Reaction is slightly acid and neutral in the surface layer, neutral and mildly alkaline in the subsoil, and mildly alkaline in the substratum.

Permeability is moderately slow. The soil is more than 60 inches deep and holds 11 to 13 inches of water available to plants.

These soils are used for woodland, wildlife habitat, and recreation.

Representative profile of Crash silt loam in an area of Crash-Artnoc complex about 1,580 feet east and 100 feet north of the southwest corner of sec. 9, T. 61 N., R. 1 E. on a north-facing slope of 65 percent:

O11-2 inches to 1 inch; needles and twigs.

O12-1 inch to 0 ; partly decomposed needles and twigs.

A21-0 to 1 inch; light gray (5Y 7/1) silt loam, gray (5Y 5/1) moist; moderate fine granular structure; soft, friable; very porous, slightly acid; abrupt discontinuous boundary. _

A22-1 inch to 3 inches ; light gray (5Y 7/1) silt loam, gray (5Y 5/1) moist; weak very thin platy structure parting to moderate very fine granular; soft, friable; slightly sticky and slightly plastic; many very fine, fine, and medium roots ; many very fine and few fine pores; many fine black concretions; neutral; abrupt smooth boundary.

A23-3 to 7 inches; light olive gray (5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; moderate thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine medium and few coarse roots; common very fine and few fine pores; many fine black concretions; neutral ; clear wavy boundary.

B21t-7 to 11 inches; light gray (5Y 7/2) silt loam, light olive gray (5Y 6/2) moist; thin and medium platy structure ; slightly hard, firm, slightly sticky and slightly plastic; many very fine, fine, and medium roots ; common very fine and fine pores; 50 to 70 percent of the horizon is dark yellowish brown bands 1/8 to 1/2 inch thick, bands have about 10 percent more clay than the matrix; few very fine black concretions; neutral; clear wavy boundary.

B22t-11 to 18 inches; light gray (2.5Y 6/2) moist; very thick platy structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and few fine pores; 50 to 70 percent of horizon has dark yellowish brown bands; few very fine concretions; mildly alkaline; clear wavy boundary.

B3t-18 to 27 inches; light olive gray (5Y 6/2) silt, grayish brown (2.5Y 5/2) moist; very thick platy structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine and fine roots matted in the upper part; many very fine and fine pores; 5 to 20 percent of the horizon has dark yellowish brown bands 1/8 to 1/4 inch thick; few very fine black concretions; mildly alkaline; gradual wavy boundary.

Cca-27 to 60 inches; light olive gray (5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; moderate thick platy structure; very hard and very firm, slightly sticky and slightly plastic; distinct lime veins and splotches between plates; strongly calcareous; mildly alkaline.

In some areas, there is a thin layer of volcanic ash between the O and A horizons. The A2 horizon has hue of 5YR and 2.5Y and value of 6 or 7 dry and 5 or 6 moist. The Bt horizon has hue of 5Y or 2.5Y and value of 6 to 7 dry and 5 or 6 moist. The Cca horizon is moderately to strongly calcareous and has distinct or prominent lime veins and splotches.

CA-Crash-Artnoc complex. This mapping unit is about 50 percent Crash silt loam and 30 percent Artnoc silt loam. The Crash soil is on north-facing terrace slopes, and the Artnoc soil is on northwestand east-facing terrace slopes. Slopes range from 45 to 95 percent.

About 10 percent of the mapping unit is included areas of Wishbone soils, and 10 percent Caboose soils. Also included are some areas where slopes are less than 45 percent and some areas where slopes are more than 75 percent.

These soils are used for woodland, wildlife habitat, and recreation. Capability subclass VIIe; wildlife group 3141; Crash soil in woodland group 1r11, Artnoc soil in woodland group 1r10.

DeVoignes Series

The DeVoignes series consists of poorly drained soils in depressions and swales in flood plains. These soils formed in mixed alluvium that is stratified with organic layers in the upper part. Slopes are 0 to 1 percent. The vegetation is black cottonwood, cattails, sedges, and rushes. Elevation is 1,755 to 2,700 feet. Precipitation is 20 to 24 inches. Mean annual soil temperature is 45 to 47°F., and the frost-free season is 120 to 140 days.

In a representative profile the surface layer is light gray mucky silt loam about 9 inches thick. The upper 15 inches of the substratum is alternate thin layers of dark gray muck and light gray silty clay loam. The lower part to a depth of 65 inches is light gray silty clay loam and silty clay. Reaction is neutral to medium acid in the upper 24 inches of the profile and neutral and mildly alkaline below.

Permeability is slow. The soil is more than 60 inches deep and holds 10 to 13 inches of water available to plants. At times in summer, the upper 3 feet of the soil dries out and cracks form, 1/2 inch to 2 inches wide (fig. 3). The seasonal high water table fluctuates from the surface to a depth of 4 feet.

These soils are used for small grain and pasture.

Representative profile of DeVoignes mucky silt loam in an area of DeVoignes-Ritz association 1,820 feet north and 100 feet west of the southeast corner of sec. 7, T. 62 N., R. 1 E.

Ap-0 to 9 inches; light gray (10YR 6/1 and 7/1) mucky silt loam, dark gray (10YR

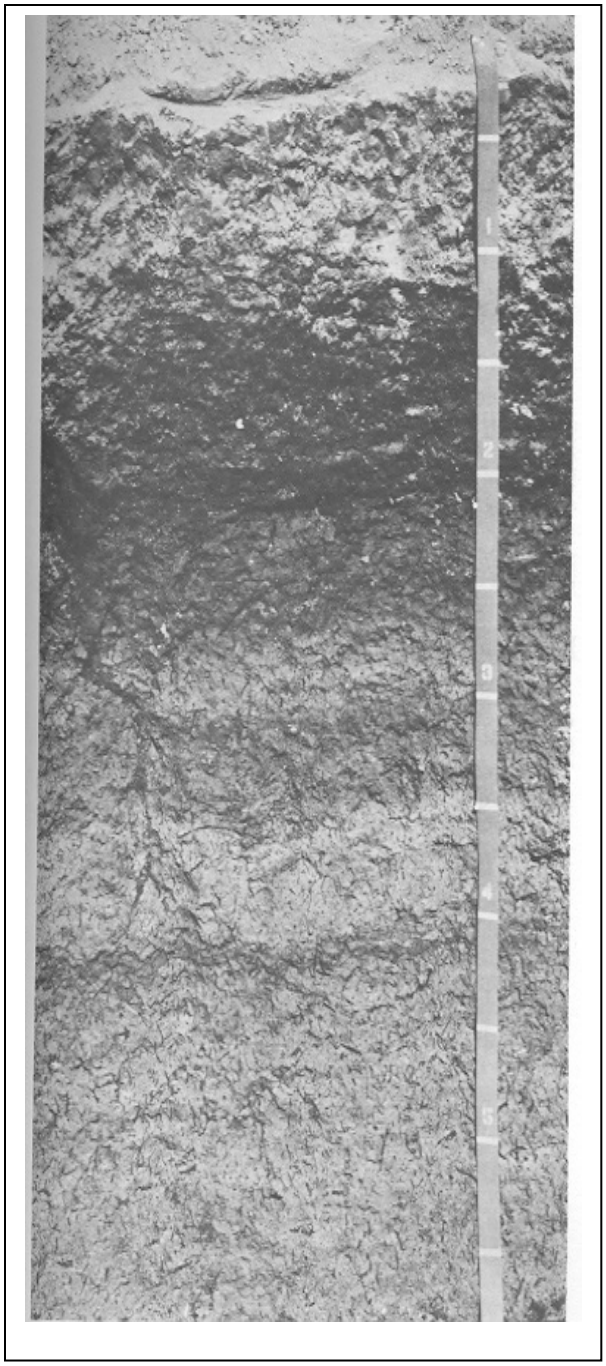

Figure 3.-Profile of DeVoignes mucky silt loam showing cracks in upper part.

4/1) moist; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; many very fine pores ; many fine roots ; moderately calcareous; neutral; abrupt wavy boundary.

C1-9 to 19 inches; dominantly dark gray (10YR 4/1) muck with thin layers of light gray (10YR 6/1) silty clay loam; massive; hard, firm; many fine pores; many fine roots ; medium acid; abrupt smooth boundary.

C2g-19 to 24 inches; alternate thin layers of muck and silty clay loam; muck part is dark gray (10YR 4/1), black (10YR 2/1), and very dark grayish brown (10YR 3/2) moist; silty clay loam part is light gray (10YR 6/1), dark gray (10YR 4/1) moist; many medium faint mottles of light yellowish brown (10YR 6/4) ; weak medium platy and weak coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; many very fine pores; neutral; abrupt wavy boundary.

IIC3g-24 to 28 inches; light gray (5Y 6/1) silty clay loam, dark gray (2.5Y 4/1) moist; many medium distinct mottles of dark brown (7.5YR 3/4) moist; weak coarse. prismatic structure; very hard, firm, sticky and plastic; many fine to coarse pores and root channels with organic staining; many snail shells; moderately calcareous; neutral; abrupt wavy boundary.

IIC4g-28 to 41 inches; light gray (5Y 6/1) silty clay loam, dark gray (5Y 4/1) moist; common prominent mottles of reddish brown (5YR 4/4) moist; weak coarse prismatic structure; very hard, firm, sticky and plastic; many fine and medium tubular pores; mildly alkaline; clear smooth boundary.

IIC5g-41 to 65 inches; light gray (5Y 7/1) stratified silty clay loam and silty clay, gray (5Y 5/1) moist; common, faint and prominent, fine and coarse mottles of light olive brown (2.5Y 5/4) and reddish brown (5YR 4/4) moist; massive; very hard, firm, sticky and plastic; many fine tubular pores; noncalcareous in upper part and moderately calcareous in lower part; mildly alkaline.

DeVoignes soils are saturated during spring runoff. They are drained in most areas but have a water table at a depth of 2 to 4 feet during the growing season. In many pedons, snail shells are in layers or are scattered throughout the profile.

The Ap horizon has hue of 10YR or 2.5Y and value of 6 or 7 dry and 4 or 5 moist. It is slightly calcareous or moderately calcareous in most pedons.

The C1 and C2g horizons are thinly stratified silty clay loam or heavy silt loam and muck to a depth of 15 to 23 inches. The C3g to C5g horizons have hue of 2.5Y or 5Y, value of 6 or 7 dry and 4 or 5 moist, and chroma of less than 2. In some places they are greenish gray or bluish gray. They have faint to prominent brown, red dish brown, light olive brown, or dark brown mottles. The Cg horizon in the lower part of the profile is thinly stratified and is mostly silty clay loam but in some pedons contains thin layers or lenses of silt loam or silty clay.

DR-DeVoignes-Ritz association. This mapping unit is about 45 percent DeVoignes mucky silt loam and 35

percent Ritz silt loam. The DeVoignes soil occupies the depressions and swales on the Kootenai River flood plain. The Ritz soil occupies the low terraces and ridges. The DeVoignes soil has the profile described as representative of the series.

About 15 percent of the mapping unit is included areas of Schnoorson soils, and 5 percent is areas of Pywell soils.

Most areas are protected from flooding by dikes. During the growing season, a system of drainage ditches and pumps controls the water table at a depth of 2 to 4 feet in the DeVoignes soil and at 4 to 6 feet in the Ritz soil.

The DeVoignes soil is used for spring wheat, barley, oats, hay, pasture, and clover seed. The Ritz soil is used for winter and spring wheat, barley, oats, hay, pasture, and clover seed. DeVoignes soil in capability unit IVw-20, wildlife group 2-11, not assigned to a woodland group; Ritz soil in capability unit IIw-20, woodland group 1w14, wildlife group 1111.

Elmira Series

The Elmira series consists of excessively drained soils on terraces. These soils formed in sandy glaciolacustrine sediment or shoreline deposits. Slopes are 0 to 20 percent. The vegetation is Douglas-fir, ponderosa pine, lodgepole pine, and pinegrass. Elevation is 2,000 to 2,500 feet. Precipitation is 23 to 28 inches. Mean annual soil temperature is 43 to 47°F., and the frost-free season is 110 to 140 days.

In a representative profile the surface layer is yellowish brown loamy sand about 4 inches thick. The subsoil is 8 inches of light yellowish brown loamy sand and 12 inches of pale brown fine sand. The substratum to a depth of 60 inches is light gray fine sand. Reaction is medium acid in the surface layer and slightly acid in the subsoil and substratum.

Permeability is rapid. The soil is more than 60 inches deep and holds 3.5 to 5 inches of water available to plants.

These soils are used for woodland, wildlife habitat, hay, and pasture.

The Elmira soils in this survey area are mapped only with Selle soils.

Representative profile of Elmira loamy sand in an area of Selle-Elmira complex 2,550 feet north and 1,200 feet west of the southeast corner of sec. 23, T. 60 N., R. 1 W.

O11-2 inches to 1/2 inch; needles and twigs.

O12-1/2 inch to 0 ; partly decomposed needles and twigs.

B21-0 to 4 inches; yellowish brown (10YR 5/4) loamy sand, dark reddish brown (5YR 2/2) moist; moderate fine granular structure; soft, very friable; many very fine and fine roots, few coarse roots ; many fine pores; medium acid; clear wavy boundary.

B22-4 to 12 inches; light yellowish brown (10YR 6/4) loamy sand, dark brown (7.5YR 3/2) moist; moderate coarse granular structure; soft., very friable; common very fine and line roots, few coarse roots; many fine pores; slightly acid; clear wavy boundary.

B23-12 to 24 inches; pale brown (10YR 6/3) fine sand, dark brown (10YR 4/3) moist ; weak coarse granular structure ; soft, very friable; few very fine, fine, and coarse roots ; many fine pores; slightly acid; diffuse wavy boundary.

C-24 to 60 inches; light gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) moist; many medium distinct iron mottles in random irregular shaped spots ; single grained; loose, very friable; few fine roots; many fine pores; slightly acid.

In some pedons, a thin discontinuous layer of volcanic ash occurs between the 0 and B horizons. The B2 horizon is typically loamy sand but in places is loamy fine sand and fine sand. Few to many wavy discontinuous thin clay bands are common in the lower part. The C horizon is loamy sand or fine sand. In some pedons lime concretions occur below a depth of 45 inches.

Farnhamton Series

The Farnhamton series consists of moderately well drained soils on natural levees on flood plains. These soils formed in alluvium. Slopes are 2 to 5 percent. The vegetation is black cottonwood, willow, Douglas-fir, and quackgrass. Elevation is 1,700 to 1,900 feet. Precipitation is 20 to 24 inches. Mean annual soil temperature is 45 to 47°F., and the frost-free season is 120 to 140 days.

In a representative profile the surface layer is light brownish gray silt loam about 7 inches thick. The upper 1.5 inches of the substratum is light brownish gray silt loam. The lower part to a depth of 60 inches is light gray and grayish brown silt loam. Reaction is mildly alkaline in the upper 22 inches and moderately alkaline below. The soil is calcareous throughout.

Permeability is moderate. The soil is more than 60 inches deep and holds 11 to 13 inches of water available to plants. The seasonal high water table is below a depth of 4 feet.

These soils are used for small grain, clover seed, pasture, and hay.

Representative profile of Farnhamton silt loam 2,160 feet east and 300 feet south of the northwest corner of sec. 29, T. 62 N., R. 1 E.

Ap-0 to 7 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak very fine and fine granular structure; slightly hard, friable; many fine roots; many very fine pores; moderately calcareous; mildly alkaline; abrupt wavy boundary.

C1-7 to 11 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; few faint mottles of brown (7.5YR 4/4) moist; weak fine and very fine granular structure; slightly hard, friable; many fine roots; many very fine pores; discontinuous dark brown (7.5YR 3/2) moist layer 1/2 to 1 1/2 inches

thick; moderately calcareous; mildly alkaline; abrupt wavy boundary.

C2-11 to 22 inches; light brownish gray (10YR 6/2) silt loam, brown (10YR 5/3) moist; few faint mottles of brown (7.5YR 4/3) moist ; weak coarse prismatic structure ; slightly hard, friable ; many fine roots ; many fine and very fine pores; moderately calcareous ; thin dark brown (7.5YR 3/2) moist layer 1/8 inch to 1 inch thick; mildly alkaline; abrupt wavy boundary.

C3-22 to 40 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; few faint mottles; weak coarse prismatic structure; slightly hard, friable; few roots; many fine pores; thin discontinuous dark brown (7.5YR 3/2) moist layer ; moderately calcareous; moderately alkaline; clear wavy boundary.

C4-40 to 60 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive; hard, friable, slightly sticky and slightly plastic; many fine pores; moderately calcareous; moderately alkaline.

The weighted average texture between depths of 10 and 40 inches is silt loam that is 11 to 18 percent clay. Snail shells are present in many pedons.

The Ap horizon has hue of 2.5Y or 10YR and value of 6 or 7 dry and 4 or 5 moist. The C1 horizon is silt loam, but in places it contains thin strata of very fine sandy loam and sandy loam. The underlying C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 dry and 3 to 5 moist, and chroma of 2 or 3. The C horizon has few to common, faint mottles. The thin, discontinuous, wavy, brownish layers in the C horizon do not occur in some pedons.

FA-Farnhamton silt loam. This soil is on natural levees parallel to the Kootenai River and along some tributary streams. About 10 percent of this mapping unit is included areas of Ritz soil and small areas in some river bends where the surface layer is fine sandy loam.

Most areas are protected from flooding by dikes. The water table is related to the height of the adjacent stream. It is generally at a depth of 4 to 5 feet, but is maintained at a depth of about 4 to 8 feet during the growing season by a system of drainage ditches' and pumps.

This soil is used for wheat, oats, barley, hay, pasture, and clover seed. Capability unit IIw-20, woodland group 1w14, wildlife group 1131.

Idamont Series

The Idamont series consists of well drained soils on glaciated mountain slopes. These soils formed in volcanic ash and the underlying glacial till. Slopes are 5 to 65 percent. The vegetation is western redcedar, Douglas-fir, western white pine, and western larch. Elevation is 2,800 to 4,400 feet. Precipitation is 30 to 40 inches. Mean annual soil temperature is 42 to 44°F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is pale brown silt loam about 7 inches thick. The upper 21 inches of the subsoil is light yellowish brown and very pale brown silt loam, and the lower 24 inches is pale brown gravelly sandy loam that has many thin bands of yellowish brown. The substratum to a depth of 60 inches is light gray very gravelly sandy loam. Reaction is slightly acid throughout.

Permeability is moderate. The soil is more than 60 inches deep and holds 8 to 10 inches of water available to plants.

These soils are used for woodland, wildlife habitat, and recreation.

The Idamont soils in this survey area are mapped only with Pend Oreille soils.

Representative profile of Idamont silt loam in an area of Pend Oreille-Idamont association about 900 feet east and 1,000 feet north of the southwest corner of sec. 16, T. 60 N., R. 1 E. on a slope of 25 percent:

O11-3 to 2 inches; needles and twigs.

O12-2 inches to 0; partly decomposed needles and twigs.

A2-0 to 1/4 inch; volcanic ash, discontinuous.

B21ir-1/4 inch to 7 inches; pale brown (10YR 6/3) silt loam, dark yellowish brown (10YR 4/4) moist; moderate fine crumb structure; soft, friable, slightly sticky and slightly plastic; many fine and medium roots ; many very fine pores; slightly acid; clear wavy boundary.

B22ir-7 to 18 inches; light yellowish brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many fine and medium roots; many very fine and fine pores; slightly acid; clear wavy boundary.

B3ir-18 to 28 inches; very pale brown (10YR 7/4) silt loam, yellowish brown (10YR 5/6) moist; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; many very fine and fine pores; slightly acid; abrupt wavy boundary.

IIB2-28 to 52 inches; pale brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure; hard, very friable; few fine roots; many fine and medium pores; many thin yellowish brown (10YR 5/4) bands; about 25 percent gravel; slightly acid; gradual wavy boundary.

IIC-52 to 60 inches; light gray (10YR 7/2) very gravelly sandy loam, grayish brown (10YR 5/2) moist; massive; slightly hard, very friable; about 80 percent gravel, cobbles, and stones; slightly acid.

Pedons in disturbed areas do not have the thin layer of volcanic ash. The Bir horizon has hue of 10YR or 7.5YR, value of 5 to 7 dry and 3 to 5 moist, and chroma of 3 or 4. It is about 2 to 4 percent clay.

The IIB horizon has hue of 10YR or 7.5YR, value

of 6 or 7 dry and 4 or 5 moist, and chroma of 3 or 4. It is mainly gravelly sandy loam but includes gravelly fine sandy loam or gravelly loam and is 15 to 35 percent coarse fragments. The IIC horizon is 75 to 95 percent gravel, cobbles, and stones.

Kriest Series

The Kriest series consists of well drained soils on glaciated mountain slopes. These soils formed in glacial till that has a very thin volcanic ash layer on the surface. Slopes are 5 to 65 percent. The vegetation is grand fir, Douglas-fir, ponderosa pine, and Myrtle pachistima. Elevation is 1,800 to 3,200 feet. Precipitation is 20 to 24 inches. Mean annual soil temperature is 43 to 45°F., and the frost-free season is 90 to 120 days.

In a representative profile the surface layer is yellowish brown gravelly sandy loam about 1 inch thick. The subsoil is light yellowish brown and pale brown gravelly sandy loam, gravelly loamy sand, and sandy loam about 30 inches thick. The substratum is very pale brown gravelly loamy sand. Weathered granite bedrock is at a depth of 41 inches. Reaction is medium acid to a depth of 16 inches and slightly Acid below.

Permeability is moderately rapid. The soil is 40 to 60 inches deep and holds 3.5 to 5 inches of water available to plants.

These soils are used for woodland, wildlife habitat, and recreation.

In this survey area, Kriest soils are mapped only with Rock outcrop-Pend Oreille soils.

Representative profile of Kriest gravelly sandy loam 500 feet north and 200 feet east of the southwest corner of sec. 15, T. 62 N., R. 1 W.

O11-2 1/2 inches to 1/2 inch ; needles and twigs.

O12-1/2 inch to 0; partly decomposed needles and twigs.

A2-0 to 1 inch; light gray volcanic ash, discontinuous.

A1-1 to 2 inches; yellowish brown (10YR 5/4) gravelly sandy loam, dark brown (7.5YR 3/2) moist; moderate very fine granular structure; soft, very friable, slightly sticky and slightly plastic ; many very fine, fine, and medium roots; many very fine pores ; 24 percent; gravel ; medium acid; abrupt wavy boundary.

B1-2 to 6 inches; light yellowish brown (10YR 6/4) gravelly sandy loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure parting to moderate very fine and fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very line pores; 24 percent gravel ; medium acid; clear wavy boundary.

B21-6 to 16 inches ; pale brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, medium, and many coarse roots ; 26 percent gravel ; medium acid; clear wavy boundary.

B22-16 to 25 inches; pale brown (10YR 6/3) gravelly loamy sand, dark brown (10YR 4/3) moist; weak very coarse prismatic structure parting to weak coarse subangular blocky ; very hard, firm; many very fine and fine pores; common fine and medium roots ; common clay films in pores and on some ped surfaces; few dark yellowish brown bands 1/16 to 1/4 inch thick; 49 percent gravel; slightly acid; clear wavy boundary.

B3-25 to 32 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 4/3) moist; weak very coarse prismatic structure parting to weak coarse subangular blocky ; very hard, firm; many fine pores; common fine and medium roots ; many dark brown clay bands 1/16 to 1/4 inch thick; 12 percent gravel ; medium acid; clear wavy boundary.

C-32 to 41 inches; very pale brown (10YR 7/3) gravelly loamy sand, brown (10YR 5/3) moist; weak very coarse prismatic structure parting to weak coarse subangular blocky ; very hard, firm; many fine pores; many dark brown bands 1/16 to 1/4 inch thick; 33 percent gravel ; slightly acid; gradual wavy boundary.

IIR-41 inches; weathered granite.

Pedons in disturbed areas do not have the thin, discontinuous, light gray layer of volcanic ash. Reaction is medium acid in the upper part of the B2 horizon and medium acid or slightly acid in the lower part. The A1 horizon has hue of 10YR or 7.5YR, value of 4 or 5 dry and 2 or 3 moist, and chroma of 2 through 4.

The B horizon averages 15 to 35 percent gravel, cobbles, and stones. It has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 2 through 4. In some pedons, a layer just below the B horizon is firm and somewhat brittle.

Pend Oreille Series

The Pend Oreille series consists of well drained soils on glaciated mountainsides. These soils formed in volcanic ash and the underlying glacial drift (fig. 4). Slopes range from 5 to 65 percent. The vegetation is western hemlock, western redcedar, grand fir, and Myrtle pachistima. Elevation is 2,200 to 3,200 feet. Precipitation is 25 to 30 inches. Mean annual soil temperature is 41 to 43°F., and the frost-free season is 70 to 100 days.

In a representative profile the surface layer is brown sandy loam about 4 inches thick. The upper 10 inches of the subsoil is yellowish brown sandy loam, and the lower 13 inches is light yellowish brown gravelly and cobbly sandy loam. The substratum to a depth of 60 inches is pale brown cobbly loamy coarse sand. Reaction is slightly acid to a depth of 27 inches and neutral below.

Permeability is moderate. The soil is more than 60

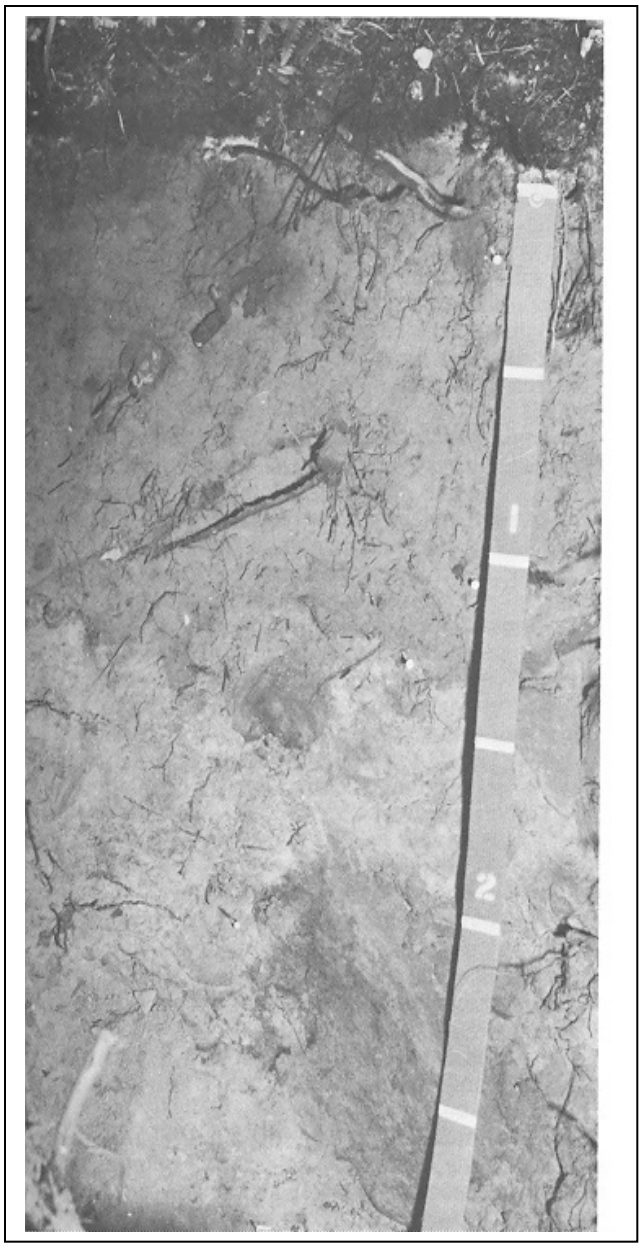

Figure 4.-Profile of Pend Oreille sandy loam showing 18-inch layer of darker colored volcanic ash over glacial drift.

inches deep and holds 6 to 8 inches of water available to plants.

These soils are used for woodland, wildlife habitat, and recreation.

Representative profile of Pend Oreille sandy loam in an area of Rock outcrop-Pend Oreille-Kriest complex about 5 miles northwest of Bonners Ferry on the Cascade road, about 600 feet south and 150 feet east of the center of sec. 14, T. 62 N., R. 1 W. on northwest facing slopes of 40 percent:

O11-3 inches to 1 inch; needles and twigs.

O12-1 inch to 0 ; moderately decomposed needles and twigs, matted.

A2-0 to 1/2 inch; volcanic ash; discontinuous.

B21ir-1/2 to 4 inches; brown (7.5YR 5/4) sandy loam, dark yellowish brown (10YR 3/4) moist; moderate fine and very fine granular structure; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots and few coarse roots; many very fine and fine pores; 12 percent gravel ; slightly acid; clear wavy boundary.

B22ir-4 to 14 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/6) moist; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots ; 12 percent gravel ; slightly acid; clear wavy boundary.

B23ir-14 to 17 inches; light yellowish brown (10YR 6/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; moderate fine and very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic ; many fine and few coarse roots; many very fine and fine pores; 24 percent gravel; slightly acid; abrupt wavy boundary.

IIB3-17 to 27 inches; light yellowish brown (10YR 6/4) cobbly sandy loam, dark brown (10YR 4/3) moist; moderate coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine and medium roots ; many very fine and fine pores ; common thin patchy clay films; 35 percent cobbles and 20 percent gravel ; slightly acid; clear wavy boundary.

IIC-27 to 60 inches; pale brown (10YR 6/3) cobbly loamy coarse sand, brown (10YR 5/3) moist; massive; hard, firm; few fine roots ; many very fine and fine pores; few thin patchy clay films; 15 percent cobbles, 4 percent stones, 10 percent gravel ; neutral.

Pedons in disturbed areas do not have the thin layer of volcanic ash. The B2ir horizon has hue of 10YR and 7.5YR and chroma of 3 to 6. In places just below the B2ir horizon, there is a layer that is somewhat brittle and massive or has weak subangular blocky structure. In some places, it has a few thin patchy clay films. The IIC horizon has hue of 10YR and 2.5Y, value of 5 to 7, and chroma of 2 and 3. It averages less than 35 percent, by weight, of gravel, cobbles, and stones and less than 18 percent clay.

PM-Pend Oreille-Idamont association. This mapping unit is about 45 percent Pend Oreille sandy loam and 30 percent Idamont silt loam. It is on glaciated mountainsides. The Pend Oreille soil is on north-facing slopes, and the Idamont soil on east-facing slopes. Slopes range from 5 to 65 percent.

About 15 percent of the mapping unit is included areas of Treble gravelly sandy loam, 5 percent is Kriest soils, and 5 percent is Rock outcrop and small stony areas. The Treble soil is on southwest-facing slopes.

This mapping unit is used for woodland, wildlife

habitat, and recreation. If slope is less than 35 percent, the Pend Oreille soil is in capability subclass VIe and woodland group loll and the Idamont soil is in capability subclass VIe and woodland group 1o10. If slope is more than 35 percent, the Pend Oreille soil is in capability subclass VIIe and woodland group lrll and the Idamont soil is in capability subclass VIIe, woodland group 1rl0, wildlife group 3141.

Porthill Series

The Porthill series consists of moderately well drained soils on high terraces. These soils formed in calcareous silty glaciolacustrine sediment. Slopes are 0 to 12 percent. The vegetation is western redcedar, western larch, western white pine, grand fir, Douglas-fir, and Myrtle pachistima. Elevation is 2,000 to 2,400 feet. Precipitation is 20 to 23 inches. Mean annual soil temperature is 43 to 45°F., and the frost-free season is 115 to 140 days.

In a representative profile the surface layer is pale brown silt loam about 13 inches thick. The subsoil is light gray heavy silty clay loam and silt loam about 19 inches thick. The substratum to a depth of 60 inches is strongly calcareous, light olive gray and light gray silty clay loam and silt loam. Reaction is slightly acid to neutral in the surface layer, neutral in the upper part of the subsoil, mildly alkaline in the lower part of the subsoil, and moderately alkaline in the substratum.

Permeability is slow. The soil is more than 60 inches deep and holds 11 to 13 inches of water available to plants.

These soils are used for alfalfa, small grain, pasture, and woodland.

Representative profile of Porthill silt loam 350 feet west and 150 feet south of the N 1/4 corner of sec. 26, T. 65 N., R. 1 W. on a slope of 2 percent

O11-1 1/2 to 1 inch; needles and twigs.

O12-1 inch to 0 ; partly decomposed needles and twigs ; trace of recent volcanic ash in lower part.

A21-0 to 7 inches; pale brown (10YR 6/3) silt loam, dark brown or brown (7.5YR 4/3) moist; weak fine platy structure parting to moderate fine granular; hard, friable, slightly sticky and slightly plastic; common fine and medium, roots ; many very fine and fine pores; slightly acid; clear wavy boundary.

A22-7 to 13 inches; pale brown (10YR 6/3) silt loam, dark brown or brown (7.5YR 4/3) moist; weak medium subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; common fine and medium roots; many very fine and fine pores; few fine black concretions; neutral; clear wavy boundary.

B2t-13 to 27 inches; light gray (2.5Y 7/2) heavy silty clay loam, olive (5Y 5/3) moist; weak coarse prismatic structure parting to moderate medium angular blocky; extremely hard, firm, sticky and plastic; common fine and medium roots ; many very fine and fine pores; common thin clay films on surfaces of peds; A2 material on surface of peds ; many fine black concretions; neutral ; clear wavy boundary.

B3t-27 to 32 inches; light gray (5Y 7/2) heavy silt loam, olive (5Y 5/3) moist; weak coarse platy structure; very hard, firm, sticky and plastic; common fine and medium roots that are matted between plates and in cracks; common very fine pores; common moderately thick clay films on surface of peds; mildly alkaline; gradual wavy boundary.

C1ca-32 to 43 inches; light olive gray (5Y 6/2) silty clay loam, olive gray (5Y 5/2) moist; moderate coarse platy structure; very hard, firm, sticky and plastic; few fine roots that are matted between plates and in cracks; common very fine pores; many distinct lime veins and splotches, strongly calcareous; moderately alkaline; clear wavy boundary.

C2ca-43 to 51 inches; light gray (5Y 7/1) silty clay loam, light olive gray (5Y 6/2) moist; moderate thick platy structure; very hard, firm, sticky and plastic; common very fine pores; strongly calcareous with common fine faint lime veins; moderately alkaline; abrupt smooth boundary.

C3-51 to 60 inches; light gray (5Y 7/2) silt loam, olive gray (5Y 5/2) moist; moderate thick platy structure; very hard, firm, sticky and plastic; strongly calcareous; moderately alkaline.

Most pedons in disturbed areas do not have a thin discontinuous layer of volcanic ash between the O and A horizons.

The A2 horizon has hue of 10YR, 7.5YR, or 2.5Y; value of 6 or 7 dry and 4 or 5 moist; and chroma of 2 or 3.

The B2t horizon has values of 4 or 5 moist. The structure ranges from weak or moderate prismatic parting to moderate or strong angular or subangular blocky. Thin to thick clay films occur on the vertical and horizontal surfaces of peds. Textures are silty clay loam or silty clay.

The depth to calcareous material ranges from 22 to 42 inches.

PR-Porthill silt loam. This soil is on high terraces in the northern part of the survey area. It has the profile described as representative of the series. Slopes are 0 to 12 percent. About 10 percent of this unit is included areas where slopes are 12 to 20 percent and 5 percent areas of Rubson silt loam where slopes are 3 to 12 percent.

This soil is used for alfalfa, wheat, oats, barley, clover and alfalfa seed, pasture, and woodland. Capability unit IIIe-23, woodland group 1d10, wildlife group 1131.

Pywell Series

The Pywell series consists of very poorly drained soils in basins and depressions of flood plains. These

soils formed in organic material derived mainly from herbaceous plants. Slopes are 0 to 1 percent. The vegetation is cattails, sedges, reeds, and scattered trees. Elevation is 1,750 to 2,800 feet. Precipitation is 20 to 30 inches. Mean annual soil temperature is 43 to 46°F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark brown muck about 10 inches thick. The subsurface layer is dark reddish brown, very dark gray, and very dark brown muck about 23 inches thick. The bottom layer to a depth of 70 inches or more is very dark gray muck. Reaction is mildly alkaline in the surface layer, neutral or slightly acid in the subsurface layer, and slightly acid in the bottom layer.

Permeability is moderate. The soil is more than 60 inches deep and holds 13 to 18 inches of water available to plants. The seasonal high water table fluctuates from the surface to a depth of 4 feet.

These soils are used for small grain and pasture.

Representative profile of Pywell muck 1,320 feet east and 2,000 feet north of the southwest corner of sec. 32, T. 62 N., R. 2 E.

Oap-0 to 10 inches; very dark brown (10YR 2/2) broken face and rubbed, sapric material; about 15 percent fiber, about 5 percent rubbed; moderate very fine and fine granular structure; many fine roots; mildly alkaline; abrupt smooth boundary.

Oa2-10 to 14 inches; dark reddish brown (5YR 2/2) broken face and rubbed, sapric material; about 25 percent fiber, about 5 percent rubbed; moderate very fine and fine granular structure; many fine roots; neutral; abrupt wavy boundary.

Oa3-14 to 22 inches; very dark gray (10YR 3/1) broken face and rubbed, sapric material ; about 25 percent fiber, less than 5 percent rubbed; massive few fine roots; 1/4 inch layer of volcanic ash; neutral; abrupt wavy boundary.

Oa4-22 to 33 inches; very dark brown (10YR 2/2) broken face rubbed, sapric material ; about 20 percent fiber, less than 5 percent rubbed; massive; 1/4 inch layer of volcanic ash ; slightly acid ; abrupt wavy boundary.

Oa5-33 to 70 inches; very dark gray (10YR 3/1) broken face and rubbed, sapric material; about 25 percent fiber, less than 5 percent rubbed; massive; 1/4 inch layer of volcanic ash; slightly acid.

In some pedons a moderate amount of the material is derived from woody plants.

The surface tier is dominantly sapric material, but includes thin layers of fibric material. Generally the structure is granular, but in some places it is subangular blocky. Below the surface tier, the organic material has granular or platy structure or is massive. The bottom tier is mainly sapric material.

Volcanic ash layers 1/4 inch to 3 inches thick are common in the subsurface and bottom tiers.

PW-Pywell muck. This soil is in basins and depressions in the Kootenai River flood plain and in stream bottoms. It has the profile described as representative of the series. About 10 percent of this mapping unit is included areas of DeVoignes soils.

In most areas dikes protect the soil from flooding. During the growing season, drainage ditches and pumps keep the water table at a depth of 2 to 4 feet.

This soil is used for pasture, oats, barley, and spring wheat. Capability unit IVw-22; not in a woodland group; wildlife group 2-11.

PY-Pywell-DeVoignes complex. This mapping unit is about 70 percent Pywell muck and 30 percent DeVoignes mucky silt loam. The Pywell soil is in basins and depressions in stream bottoms. The DeVoignes soil is in depressions in stream bottoms. The DeVoignes soil has a profile similar to the one described as representative of the series, but the surface layer is peat and is medium acid.

Unprotected areas are subject to yearly flooding. The water table is at or near the surface 6 to 10 months of the year.

This unit is used for pasture, hay, wildlife habitat, and woodland. Capability unit Vw-20 ; wildlife group 2-11; woodland group not assigned.

Ritz Series

The Ritz series consists of poorly drained soils on low terraces and ridges. These soils formed in calcareous silty alluvium. Slopes are 0 to 2 percent. The vegetation is black cottonwood, willow, thinleaf alder, and sedge. Elevation is 1,755 to 1,765 feet. Precipitation is 20 to 24 inches. Mean annual soil temperature is 45 to 47°F., and the frost-free season is 120 to 140 days.

In a representative profile (fig. 5) the surface layer is light brownish gray silt loam about 8 inches thick. The substratum to a depth of 46 inches is mottled light gray silt loam. To a depth of 60 inches, it is thinly stratified, mottled light gray silt loam and very fine sandy loam. Reaction is mildly alkaline in the upper 24 inches and moderately alkaline below.

Permeability is moderate. The soil is more than 60 inches deep and holds 11 to 13 inches of water available to plants. The seasonal high water table fluctuates from the surface to a depth of 3 feet. The soil is saturated during spring runoff. The water table is lowered to a depth of 4 to 6 feet during the growing season by a system of ditches and pumps.

These soils are used for small grain, clover seed, and pasture.

Representative profile of Ritz silt loam in an area of Ritz-Schnoorson complex 420 feet east and 1,460 feet north of the southwest corner of sec. 7, T. 62 N., R. 1 E.

Ap-0 to 8 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak very fine and fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots ; slightly calcareous; mildly alkaline; abrupt wavy boundary.

Clg-8 to 18 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; many medium distinct mottles of yellow ish brown (10YR 5/6) ; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky

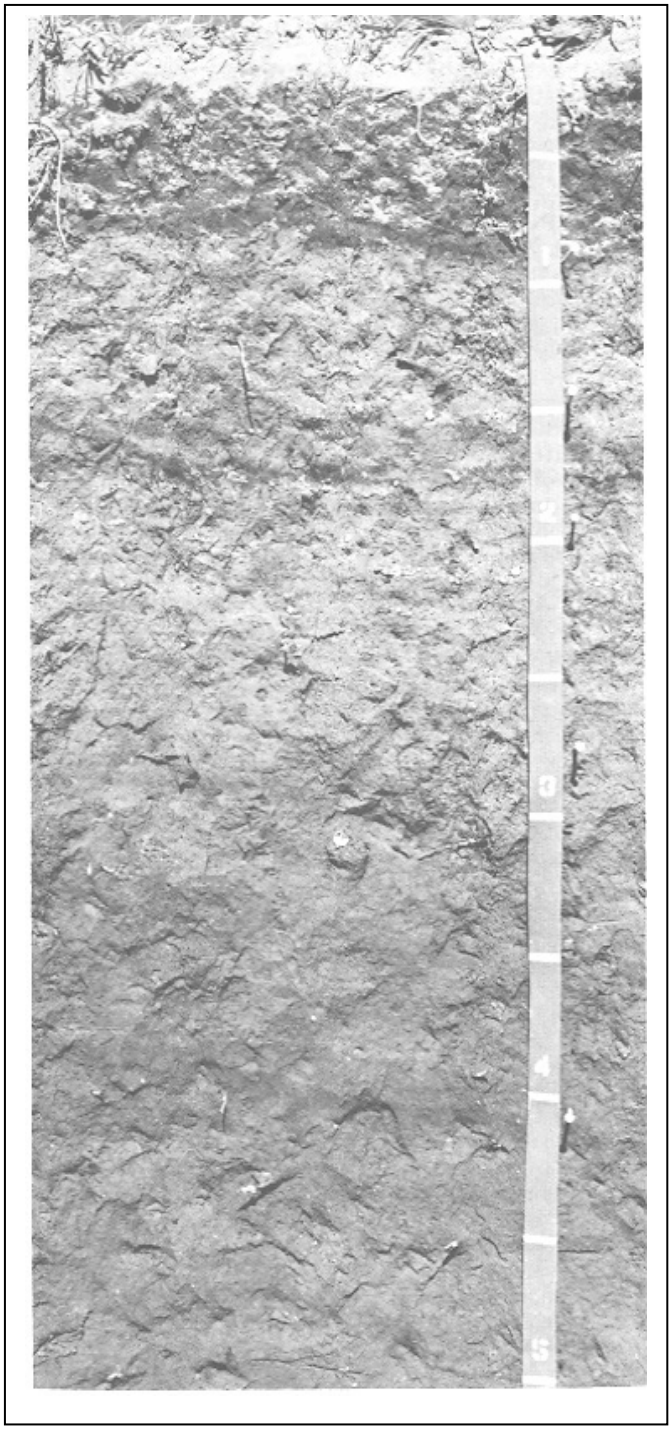

Figure 5.-Profile of Ritz silt loam. Upper 12 inches is moist after a rain.

and slightly plastic; common fine roots; common fine pores; slightly calcareous; mildly alkaline; abrupt wavy boundary.

C2g-18 to 24 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; many medium distinct mottles of yellowish brown (10YR 5/4) ; weak coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; common fine roots ; common very fine pores; slightly calcareous; mildly alkaline; abrupt wavy boundary.

C3g-24 to 32 inches; light gray (2.5Y 7/2) silt loam, gray (5Y 5/1) moist; many medium distinct mottles of yellowish brown (10YR 5/4) ; massive; hard, friable, slightly sticky and slightly plastic; common fine roots ; common very fine and fine pores; moderately calcareous; moderately alkaline; abrupt wavy boundary.

C4g-32 to 46 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; many medium distinct mottles of dark yellowish brown (10YR 4/4) ; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine pores; moderately calcareous; moderately alkaline; clear wavy boundary.

C5g-46 to 60 inches; light gray (2.5Y 7/2) thinly stratified silt loam and very fine sandy loam, grayish brown (2.5Y 5/2) moist; many medium distinct mottles of dark yellowish brown (10YR 4/4) ; massive; slightly hard, very friable, nonsticky and nonplastic ; common fine pores; moderately calcareous; moderately alkaline.

Between depths of 10 and 40 inches, the soil is 13 to 18 percent clay and less than 15 percent fine and coarser sand. The soils are mildly alkaline or moderately alkaline throughout. They are slightly calcareous or moderately calcareous. Snail shells are commonly between depths of 10 and 40 inches. Buried thin Al horizons are common.

The Ap horizon has hue of 10YR or 2.5Y and value of 6 or 7 dry. It is dominantly silt loam or silt but is very fine sandy loam in some places.

The Cg horizon has many distinct or prominent yellowish brown, dark yellowish brown, or brown mottles. It has hue of 10YR, 2.5Y, or 5Y, value of 6 or 7 dry, and chroma of 2 or 1.

RO-Ritz-Schnoorson complex. This mapping unit is about 55 percent Ritz silt loam and 45 percent Schnoorson silty clay loam. The Ritz soil occupies low terraces and ridges on the Kootenai River flood plain. It has the profile described as representative of the series. The Schnoorson soil is in basins and swales in the Kootenai River flood plain. Slopes are 0 to 2 percent.

In most areas dikes protect the soils from flooding. During the growing season, drainage ditches and pumps keep the water table at a depth of 2 to 4 feet in the Schnoorson soil and at 4 to 6 feet in the Ritz soil.

This unit is used for wheat, oats, and barley. Capability unit IVw-20 ; Ritz soil in woodland group 1w14, wildlife group 1111; Schnoorson soil in wildlife group 2-11, woodland group not assigned.

Rock Outcrop

Rock outcrop is exposures of barren rock. In places

it has a mantle of soil material less than 4 inches thick. Slopes range from 0 to more than 100 percent.

RP-Rock outcrop-Pend Oreille-Kriest complex. This mapping unit is about 45 percent Rock outcrop, 30 percent Pend Oreille sandy loam, and 15 percent Kriest gravelly sandy loam. Rock outcrop is on the barren bedrock exposures on glaciated mountain slopes. The Pend Oreille and Kriest soils are on glaciated mountainsides. The Pend Oreille soil has a northerly aspect, and the Kriest soil a southerly aspect. The Pend Oreille soil has the profile described as representative of the series. Slopes are 5 to 65 percent.

These soils occur in such an intricate pattern that it is not practical to map them separately. About 10 percent of this unit is included areas of Idamont soils and 5 percent areas of Treble soils.

This unit is used for woodland, wildlife habitat, and recreation. Capability subclass VIIs ; Rock outcrop in wildlife group 4444, not assigned to woodland group. If slope is as much as 35 percent, Pend Oreille soil in woodland group loll. Kriest soil in 3o9 if slope is more than 35 percent, Pend Oreille soil in woodland group 1r11, Kriest soil in 3r9. Both soils are in wildlife group 3141.

RT-Rock outcrop-Treble complex. This mapping unit is about 55 percent Rock outcrop and 30 percent Treble gravelly sandy loam. Rock outcrop is the barren bedrock exposure on glaciated mountainsides. The Treble soil is on glaciated southwest facing mountainsides. Slopes are 5 to 65 percent.

These soils occur in such an intricate pattern that it is not practical to map them separately. About 5 percent of this unit is included areas of Kriest soils, 5 percent Idamont soils, and 5 percent Pend Oreille soils.

The Treble soil is used for woodland, wildlife habitat, and recreation. Rock outcrop has little value except for esthetic purposes. Capability subclass VIIs ; Rock outcrop in wildlife group 4444, not assigned to woodland group. If slope is 5 to 35 percent, Treble soil in woodland group 2o7. If slope is 35 to 65 percent, Treble soil in woodland group 2r7, wildlife group 3141.

Rubson Series

The Rubson series consists of well drained soils on high terraces. These soils formed in glaciolacustrine sediment. Slopes are 0 to 12 percent. The vegetation is western hemlock, western redcedar, western white pine, and Myrtle pachistima. Elevation is 2,100 to 2,700 feet. Precipitation is 23 to 28 inches. Mean annual soil temperature is 41 to 44° F, and the frost-free season is 110 to 135 days.

In a representative profile the surface layer is pale brown silt loam about 14 inches thick. The next 15 inches is very pale brown and light gray silt loam. The next 26 inches is reddish yellow, light gray, and brown silt loam and very fine sandy loam. The substratum to a depth of 68 inches is light gray loamy very fine sand. Reaction is slightly acid and medium acid to a depth of 55 inches and mildly alkaline below.

Permeability is moderate. The soil is more than 60 inches deep and holds 11 to 12 inches of water available to plants.

These soils are used for hay, small grain, pasture, woodland, wildlife habitat, and recreation.

Representative profile of Rubson silt loam about 200 feet west and 300 feet north of the southeast corner of sec. 16, T. 61 N., R. 1 E. on a slope of 1 percent:

O11-3 inches to 1 inch; needles and twigs.

O12-1 inch to 0 ; partially decomposed needles and twigs.

A2-0 to 1/2 inch; volcanic ash; discontinuous.

V21ir-1/2 inch to 2 inches; pale brown (10YR 6/3) silt loam, brown (7.5YR 5/2) moist; moderate fine crumb structure; soft, friable, slightly sticky and slightly plastic ; many fine and coarse roots ; many very fine pores; slightly acid; clear wavy boundary.

B22ir-2 to 8 inches; pale brown (10YR 6/3) silt loam, brown (7.5YR 5/4) moist; weak fine crumb structure; soft, friable, slightly sticky and slightly plastic; many fine and coarse roots; many very fine and few medium pores; slightly acid; clear wavy boundary.

B23ir-8 to 14 inches; pale brown (10YR 6/3) silt loam, brown (7.5YR 5/4) moist; weak medium and fine subangular blocky structure; hard, slightly sticky and slightly plastic; many fine and coarse roots; many very fine pores; medium acid; clear wavy boundary.

IIA21b-14 to 23 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 6/3) moist; weak coarse angular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine and coarse roots; many very fine and fine pores; slightly acid; clear wavy boundary.

IIA22b-23 to 29 inches; light gray (10YR 7/2) silt loam, pale brown (10YR 6/3) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and coarse roots ; many very fine pores ; slightly acid; abrupt wavy boundary.

IIB21tb-29 to 32 inches; reddish yellow (7.5YR 6/6) silt loam, yellowish brown (10YR 5/4) and dark yellowish brown (10YR 3/4) moist; massive; very hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine and fine pores; many very thin and thin clay films on pores; medium acid; abrupt wavy boundary.

IIIA'2-32 to 50 inches; light gray (10YR 7/2) very fine sandy loam, pale brown (10YR 6/3) moist; massive; hard, friable; few fine and coarse roots; many very fine pores; one wavy and discontinuous yellowish brown (10YR 5/4) lamella about 2 inches thick; slightly acid; abrupt wavy boundary.

IIIB'2-50 to 55 inches; brown (10YR 5/3) very fine sandy loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly

plastic; many very fine pores; slightly acid; abrupt wavy boundary.

IIIC-55 to 68 inches; light gray (10YR 7/2) loamy very fine sand, grayish brown (2.5Y 5/2) moist; massive; soft, many fine pores; mildly alkaline.

The Bir horizon has value of 6 or 7 dry and 4 or 5 moist. The IIA2b horizon has value of 6 or 7 dry and 5 or 6 moist and chroma of 2 or 3. It is 2 to 4 percent clay. The IIB2tb horizon has value of 5 or 6 dry. It is 10 to 17 percent clay. The IIIC horizon consists of neutral or mildly alkaline lacustrine sediments.

In some pedons the soil is calcareous below a depth of 40 inches.

RU-Rubson silt loam. This soil is on broad glaciolacustrine terraces. It has the profile described as representative of the series. Slopes are 0 to 12 percent. About 5 percent of this mapping unit is included areas of Rubson silt loam, 12 to 20 percent slopes, and 5 percent a complex of Selle fine sandy loam and Elmira loamy sand.

This soil is used for hay, pasture, wheat, and woodland. A small acreage where slopes are 0 to 3 percent is used for irrigated hops. Capability unit IIIe-23, woodland group 1o11, wildlife group 2141.

RW-Rubson-Porthill association. This mapping unit is about 75 percent Rubson silt loam and 20 percent Porthill silt loam. It occupies broad glaciolacustrine terraces. Slopes are 0 to 12 percent. About 5 percent of this unit is included areas of Rubson silt loam, 12 to 20 percent slopes.

This unit is used for wheat, oats, barley, and alfalfa. Rubson soil in capability unit IIIe-23, woodland group loll, wildlife group 2141; Porthill soil in capability unit IIIe-23, woodland group 1dl0, wildlife group 1131.

Schnoorson Series

The Schnoorson series consists of poorly drained soils in basins and swales of the ridge-swale complex on the Kootenai River flood plain. These soils formed in alluvium (fig. 6). Slopes are 0 to 1 percent. The vegetation is sedges, thin leaf alder, willow, and rushes. Elevation is 1,755 to 1,765 feet. Precipitation is 20 to 24 inches. Mean annual soil temperature is 45 to 47°F., and the frost-free season is 120 to 140 days.

In a representative profile the surface layer is light brownish gray silty clay loam about 6 inches thick. The substratum to a depth of 40 inches is mottled light gray silty clay loam. Below this, to a depth of 65 inches, is mottled light gray silty clay. Reaction is mildly alkaline to a depth of 40 inches and neutral below.

Permeability is moderately slow. The soil is more than 60 inches deep and holds 11 to 12 inches of water available to plants. The seasonal high water table fluctuates from the surface to a depth of 4 feet. These soils are saturated during spring runoff and, unless drained, the water table is at a depth of less than 40 inches during the first part of the growing season.

Representative profile of Schnoorson silty clay loam in area of Schnoorson-Ritz association 2,440 feet east and 1,140 feet south of the northwest corner of sec. 29, T. 62 N., R. 1 E.

Ap-0 to 6 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak very fine granular structure; slightly hard, friable, slightly sticky and plastic; many fine pores; moderately calcareous; mildly alkaline; abrupt wavy boundary.

Clg-6 to 20 inches; light gray (2.5Y 7/1) silty clay loam, grayish brown (2.5Y 5/2) moist; common coarse distinct mottles of yellowish brown (10YR 5/4) and brown (7.5YR 5/4) ; weak coarse prismatic structure; very hard, firm, sticky and plastic; many fine pores; moderately

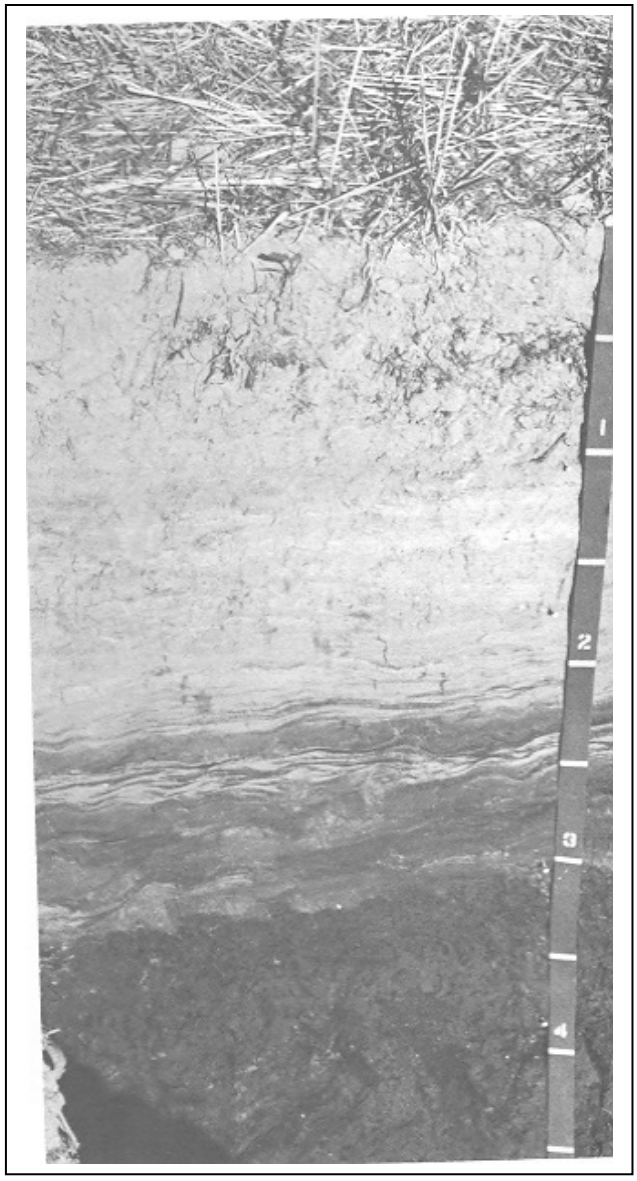

Figure 6.-Profile of Schnoorson silty clay loam. The darker colored lower part is wet. Bands show stratification of alluvium.

calcareous; mildly alkaline; clear wavy boundary.

C2g-20 to 31 inches; light gray (5Y 7/1) silty clay loam, dark gray (5Y 4/1) moist; common coarse prominent mottles of brown (7.5YR 5/4) and light reddish brown (2.5YR 6/3) weak coarse prismatic structure; very hard, firm, sticky and plastic; many fine and medium pores; mildly alkaline; clear wavy boundary.

C3g-31 to 40 inches ; light gray (2.5Y 7/1) silty clay loam, dark gray (2.5Y 4/1) moist ; common coarse prominent mottles of brown (7.5YR 5/4) and reddish brown (2.5YR 4/3) ; massive; very hard, firm, sticky and plastic ; many fine and medium pores; mildly alkaline; clear wavy boundary.

C4g-40 to 65 inches; light gray (2.5Y 7/1) silty clay, bluish gray (5B 5/1) moist; common coarse prominent mottles of brown (7.5YR 5/4) ; massive; very hard, very firm, very sticky and very plastic; fine and medium pores ; neutral.

Texture between depths of 10 and 40 inches averages silty clay loam and 27 to 34 percent clay. Reaction is neutral to mildly alkaline. Snail shells are common in the upper part of the profile.

The Ap horizon has hue of 2.5Y or 10YR, value of 6 or 7 dry, and chroma of 1 or 2. It is slightly or moderately calcareous.

The Cg horizon has value of 6 or 7 dry and 4 or 5 moist. It has distinct or prominent mottles that have hue of 10YR, 7.5YR, 5YR, and 2.5YR and chroma of 3 through 6. This horizon is commonly silty clay loam and has weak to moderate coarse prismatic structure, but it is massive in the lower part in most places.

The soils occasionally dry out to 3 feet and cracks 1/2 to 2 inches wide form below the Ap horizon.

SA-Schnoorson-Ritz association. This mapping unit is about 60 percent Schnoorson silty clay loam and 40 percent Ritz silt loam. The Schnoorson soil is in basins, depressions, and swales in the Kootenai River flood plain. It has the profile described as representative of the series. The Ritz soil is on low terraces.

In most areas dikes protect the soil against flooding. During the growing season, drainage ditches and pumps keep the water table at a depth of about 2 to 4 feet in the Schnoorson soil and at 4 to 6 feet in the Ritz soil.

The Schnoorson soil is used for spring wheat, oats, and barley. The Ritz soil is used for wheat, oats, barley, hay, pasture, and clover seed. Schnoorson soil in capability unit IVw-20, wildlife group 2-11, not assigned to woodland group; Ritz soil in capability unit IIw-20, woodland group 1w14, wildlife group 1111.

Seelovers Series

The Seelovers series consists of poorly drained soils on stream bottoms. These soils formed in alluvium. Slopes are 0 to 2 percent. The vegetation is western redcedar, paper birch, black cottonwood, and devilsclub. Elevation is 2,100 to 2,800 feet. Precipitation is 24 to 28 inches. Mean annual soil temperature is 43 to 45°F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark brown silt loam about 6 inches thick. The subsoil is about 23 inches thick. It is very dark grayish brown silt loam in the upper 6 inches and mottled grayish brown silt loam in the lower 17 inches. The substratum to a depth of 60 inches is olive gray silt loam. Reaction is slightly acid throughout.

Permeability is moderately slow. The soil is more than 60 inches deep and holds 11 to 13 inches of water available to plants. The seasonal high water table fluctuates between the surface and a depth of 1.5 feet.

These soils are used for small grains, pasture, and woodland.

Representative profile of Seelovers silt loam about 1,650 feet east and 500 feet south of the northwest corner of sec. 25, T. 65 N., R. 1 W.

A1-0 to 6 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; many fine and very fine pores; slightly acid; clear wavy boundary.

B21-6 to 12 inches ; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure that parts to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine and medium roots; many very fine and fine pores; slightly acid; clear wavy boundary.

B22g-12 to 17 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; common medium faint mottles; weak medium prismatic structure that parts to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots ; many very fine and fine pores; slightly acid; clear wavy boundary.

B3g-17 to 29 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; common medium and coarse prominent mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine pores ; slightly acid; abrupt wavy boundary.

Cg-29 to 60 inches; olive gray (5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; common medium and coarse prominent mottles; massive; hard, firm, sticky and plastic; many very fine and fine pores ; slightly acid.

The A1 horizon has value of 2 or 3 moist and 4 or 5 dry. The structure is fine and medium subangular blocky or fine granular.

The B2 horizon is silt loam and loam. It has hue of 10YR, 2.5Y, or 5Y and value of 4 through 7 dry. The structure ranges from weak or moderate, coarse or medium, prismatic to weak or moderate subangular blocky.

The B3g horizon is silt loam or silty clay loam. It

has hue of 5Y or 2.5Y, value of 5 or 6 moist, and 6 or 7 dry. It has distinct to prominent and common to many mottles.

The Cg horizon is silty clay loam or silt loam and has many or common, distinct or prominent mottles. It has hue of 5Y, 5GY, 5B, or 2.5Y; value is 5 through 7 moist and 6 or 7 dry.

SE-Seelovers silt loam. This soil is on stream bottoms. Slopes are less than 2 percent. About 10 percent of this mapping unit is included areas of Rubson soils, 5 percent DeVoignes soils, 5 percent Bane soils, 5 percent Stien soils, and 2 percent Pywell soils. Also included are small areas where gravel and cobbles are between depths of 20 and 40 inches.

This soil is used for woodland, oats, pasture, and grass hay crops. Capability unit IVw-21, woodland group 1w16, wildlife group 2-11.

Selle Series

The Selle series consists of well drained soils on terraces. These soils formed in sandy glaciolacustrine sediment. Slopes are 0 to 7 percent. The vegetation is western redcedar, grand fir, western white pine, and Myrtle pachistima. Elevation is 2,000 to 2,500 feet. Mean annual precipitation is 23 to 28 inches. Mean annual soil temperature is 43 to 47°F., and the frost-free season ranges from 110 to 140 days.

In a representative profile the surface layer is brown and light yellowish brown fine sandy loam about 15 inches thick. The subsoil is brown and yellowish brown loamy fine sand and sand about 25 inches thick. The substratum to a depth of 60 inches is pale brown sand. Reaction is medium acid in the surface layer, slightly acid and neutral in the subsoil, and neutral in the substratum.

Permeability is very rapid. The soil is more than 60 inches deep and holds 6 to 8 inches of water available to plants.

These soils are used for woodland, small grain, alfalfa, and pasture.

Representative profile of Selle fine sandy loam in an area of Selle-Elmira complex 1,250 feet west and 2,600 feet north of the southeast corner of sec. 33, T. 60 N., R. 1 W.

O11-2 to 1 1/2 inches; needles and twigs.

O12-1 1/2 inches to 0 ; partly decomposed needles and twigs matted.

A2-0 to 1/4 inch; volcanic ash; discontinuous.

B21ir-1/4 to 4 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots ; many very fine and fine pores; medium acid; clear wavy boundary.

B22ir-4 to 15 inches; light yellowish brown (10YR 6/4) fine sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots ; many very fine and fine pores; medium acid; gradual wavy boundary.

B23ir-15 to 31 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable; many very fine and fine roots; many very fine and fine pores; slightly acid ; clear wavy boundary.

B24ir-31 to 40 inches; yellowish brown (10YR 5/4) sand, dark brown (10YR 3/3) moist; massive; loose; many fine roots; many very fine and fine pores; 35 percent of matrix has 1/8 to 1/4 inch thick dark yellowish brown (10YR 4/4) lamellae; many fine to coarse iron manganese concretions ; neutral; gradual wavy boundary.

C-40 to 60 inches; pale brown (10YR 6/3) sand, brown (10YR 4/3) moist; single grained ; loose; many very fine and fine pores; neutral.

The Bir horizon has chroma of 3, 4, or 6. Lamellae l to 2 inches thick occur in the lower part of the Bir horizon and make up 10 to 50 percent of the matrix. The C horizon is medium and coarse sand.

SL-Selle fine sandy loam. This nearly level to gently sloping, undulating or duny soil is on glaciolacustrine terraces. Slopes range from 0 to 7 percent. About 10 percent of the mapping unit is included areas of Elmira soils and 5 percent Rubson soils.

This soil is used for wheat, oats, barley, hay, pasture, and woodland. Capability unit IVs-24, dryland; woodland group 1o10; wildlife group 2141.

SR-Selle-Elmira complex. This mapping unit is on terraces. It is about 60 percent Selle fine sandy loam and 40 percent Elmira loamy sand. The nearly level to gently sloping Selle soil has the profile described as representative of the series. The Elmira soil is nearly level to hilly or duny. Slopes range from 0 to 20 percent.

These soils occur in such intricate patterns that it is not practical to show them separately on the map.

Some areas are tilled. Others are used for woodland, wildlife habitat, and pasture. Capability subclass VIs ; Selle soil in woodland group 1o10, wildlife group 2141; Elmira soil in woodland group 4s8, wildlife group 3242.

Stien Series

The Stien series consists of well drained soils on glacial moraines. These soils formed in volcanic ash and the underlying glacial drift. Slopes are 0 to 12 percent. The vegetation is lodgepole pine, Douglas-fir, and Myrtle pachistima. Elevation is 2,200 to 2,800 feet. Precipitation is 25 to 30 inches. Mean annual soil temperature is 41 to 45° F., and the frost-free season is 90 to 110 days.

In a representative profile the surface layer is light yellowish brown gravelly silt loam about 4 inches thick. The subsoil is about 21 inches thick. It is light yellowish brown very gravelly silt loam in the upper part and very pale brown very cobbly sandy loam in the lower part. The substratum to a depth of 60 inches is very pale brown very gravelly coarse sand. Reaction is slightly acid throughout.

Permeability is moderately rapid. The soil is more than 60 inches deep and holds 3.5 to 4.5 inches of water available to plants.

These soils are used for woodland, wildlife habitat, recreation, small grain, hay, and pasture.

Representative profile of Stien gravelly silt loam in an area of Stien-Pend Oreille association about 900 feet north of the center of sec. 21, T. 65 N., R. 2 E.

O11-2 to 1 inch; needles and twigs.

O12-1 inch to 0; partly decomposed needles and twigs.

B21ir-0 to 4 inches; light yellowish brown (10YR 6/4) gravelly silt loam, dark brown (7.5YR 3/4) moist; weak fine crumb structure; soft, friable, slightly sticky and slightly plastic; many fine and medium roots; many very fine pores; 24 percent gravel; slightly acid; clear wavy boundary.

B22ir-4 to 15 inches; light yellowish brown (10YR 6/4) very gravelly silt, loam, dark brown or brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine and medium roots; many very fine pores; 64 percent gravel and cobbles ; slightly acid; clear wavy boundary.

IIB3ir-15 to 25 inches; very pale brown (10YR 7/4) very cobbly sandy loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure ; loose, few fine roots; many fine pores; 88 percent cobbles and gravel ; slightly acid; clear wavy boundary.

IIIC-25 to 60 inches; very pale brown (10YR 7/3) very gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grained; loose, 68 percent gravel and cobbles; slightly acid.

Some undisturbed areas have a very thin layer of volcanic ash between the 0 and B horizons. The Bir horizon has value of 5 through 7 dry and chroma of 4 through 6.

ST-Stien cobbly silt loam. This soil is on a high glacial terrace. Slopes range from 0 to 12 percent. This soil has a profile similar to the one described as representative of the series, but the surface layer is dominantly cobbles. About 25 percent of the mapping unit is included areas of Stien gravelly silt loam. Also included are small areas where the surface layer is less than 15 percent gravel or cobbles and small areas where slopes are more than 12 percent.

This soil is used for woodland, alfalfa, pasture, and wildlife habitat. Capability unit IVs-24, woodland group 1f8, wildlife group 2141.

SW-Stien-Pend Oreille association. This mapping unit is about 75 percent Stien gravelly silt loam and 25 percent Pend Oreille sandy loam. The Stien soil is on glacial moraines in valleys. It has the profile described as representative of the series. The Pend Oreille soil is on glaciated mountain slopes. Slopes range from 0 to 35 percent. Included in mapping are cobbly areas.

The Stien soil is used for woodland, wheat, oats, and pasture. The Pend Oreille soil is used for woodland, wildlife habitat, and recreation. Stien soil in capability unit IVs-24, wildlife group 2141, woodland group 1f8; Pend Oreille soil in capability subclass VIe, woodland group loll, wildlife group 3141.

Treble Series

The Treble series consists of well drained soils on glaciated mountainsides. These soils formed in glacial till. Slopes are 5 to 65 percent. The vegetation is Douglas-fir, ponderosa pine, snowberry, and pinebark. Elevation is 1,800 to 3,200 feet. Precipitation is 24 to 28 inches. Mean annual soil temperature is 44 to 46°F., and the frost-free season is 100 to 130 days.

In a representative profile the surface layer is dark yellowish brown gravelly sandy loam about 2 inches thick. The subsoil is 20 inches thick. In sequence from the top is 4 inches of dark brown gravelly sandy loam, 6 inches of yellowish brown gravelly sandy loam, and 10 inches of light yellowish brown very gravelly sandy loam. The substratum is yellowish brown very gravelly sandy loam and gravelly sandy loam. Weathered bedrock is at a depth of 42 inches. Reaction is neutral in the surface layer, slightly acid in the upper part of the subsoil, and medium acid in the lower part.

Permeability is moderately rapid. The soil is 40 to 60 inches deep to bedrock and holds 3.5 to 6 inches of water available to plants.

These soils are used for woodland, wildlife habitat, and recreation. The Treble soils in this survey area are mapped only with Rock outcrop.

Representative profile of Treble gravelly sandy loam in an area of Rock outcrop-Treble complex west of Bonners Ferry on the Myrtle Creek-Cascade Creek road, about 400 feet north and 1,100 feet east of the center of sec. 23, T. 62 N., R. 1 W., on a south-facing slope of 30 percent

O11-2 to 1 inch; needles and twigs.

O12-1 inch to 0 ; partly decomposed needles and twigs.

A1-0 to 2 inches; dark yellowish brown (10YR 4/4) gravelly sandy loam, very dark brown (10YR 2/2) moist; moderate very fine crumb structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many fine pores; 27 percent gravel; neutral; abrupt wavy boundary.

B21ir-2 to 6 inches; dark brown (7.5YR 4/4) gravelly sandy loam, dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure parting to moderate medium crumb; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; common fine pores ; 36 percent gravel ; slightly acid; clear wavy boundary.

B22ir-6 to 12 inches; yellowish brown (10YR 5/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and

fine roots ; many very fine pores; 28 percent gravel; slightly acid clear wavy boundary.

B23ir-12 to 22 inches; light yellowish brown (10YR 6/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; moderate coarse subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few very fine and medium roots matted on ped surfaces; many very fine and few fine pores; few thin patchy clay films; 40 percent gravel; medium acid; clear wavy boundary.

Cl-22 to 32 inches; yellowish brown (10YR 5/4) very gravelly sandy loam, dark yellowish brown (10YR 4/4) moist ; moderate coarse subangular blocky structure; very hard, firm, slightly sticky and slightly plastic few fine and medium roots matted on ped surfaces ; few thin patchy clay films; 55 percent gravel; slightly acid; clear wavy boundary.

C2-32 to 42 inches; yellowish brown (10YR 5/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; moderate coarse subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few fine and medium roots ; many very fine and few fine pores; few thin patchy clay films ; 29 percent gravel ; slightly acid.

IIR-42 inches; weathered bedrock.

In some pedons, where the surface has not been disturbed, there is a thin layer of volcanic ash between the O and A horizons.

The Al horizon has hue of 10YR or 7.5Y, value of 4 or 5 dry and 2 to 4 moist, and chroma of 2 through 4. It is gravelly sandy loam or gravelly fine sandy loam.

The Bir horizon has value of 4 through 6 dry. The structure is granular, subangular blocky, or prismatic. This horizon is 25 to 40 percent coarse fragments, mostly gravel and cobbles; more than 15 percent by weight fine or coarser sand; and 5 to 8 percent clay. In some pedons, the lower part of the Bir horizon is firm or very firm, somewhat brittle, and has weak or moderate subangular blocky structure.

The C horizon has hue of 10YR or 7.5YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 or 4. It averages 35 to 60 percent coarse fragments, mostly gravel and cobbles with some stones.

Wishbone Series

The Wishbone series consists of well drained soils on terraces. These soils formed in calcareous glacio-lacustrine sediment. Slopes are 45 to 75 percent. The vegetation is Douglas-fir, ponderosa pine, snowberry, and pinegrass. Elevation is 1,800 to 2,200 feet. Precipitation is 20 to 24 inches. Mean annual soil temperature is 47 to 49°F., and the frost-free season is 110 to 140 days.

In a representative profile the surface layer is light brownish gray silt loam about 5 inches thick. The subsurface layer, about 13 inches thick, is gray silt loam that has many thin wavy bands of pale brown. The subsoil to a depth of 60 inches is strongly calcareous light gray silt loam with some thin wavy bands of pale brown. Reaction is slightly acid in the surface layer, neutral in the subsurface layer, and mildly alkaline in the subsoil.

Permeability is moderate. The soil is more than 60 inches deep and holds 11 to 13 inches of water available to plants.

These soils are used for woodland, wildlife habitat, and recreation.

Representative profile of Wishbone silt loam in an area of Wishbone-Caboose complex, about 250 feet east and 200 feet south of the center of sec. 9, T. 61 N., R.1 E. on a south-facing slope of 55 percent:

O11-2 to 1 inch; needles, twigs, and grass.

O12-1 inch to 0 ; partly decomposed needles, twigs, and grass.

A21-0 to 1/2 inch; volcanic ash; discontinuous.

A22-1/2 to 5 inches; light brownish gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; weak thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine to coarse roots; many very fine and fine pores ; many very fine and fine black concretions ; slightly acid; clear wavy boundary.

A&B-5 to 18 inches; light gray (2.5Y 7/2) silt loam, dark grayish brown (2.5Y 4/2) moist; moderate thin platy and weak coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many very fine to coarse roots; many very fine pores; wavy pale brown lamellae 1/16 inch to 2 inches thick on 20 percent of the matrix; thin clay films on lamellae; common very fine and fine dark colored black concretions; neutral; abrupt wavy boundary.

B3tca-18 to 60 inches; light gray (5YR 7/2) silt loam, olive gray (5Y 5/2) moist; massive; hard, firm, slightly sticky and slightly plastic; wavy pale brown lamellae 1/16 inch to 2 inches thick on 10 to 20 percent of the horizon; few thin clay films and thin layers of calcium carbonate between lamellae; common very fine and fine roots; few very fine pores; few very fine black concretions; strongly calcareous; mildly alkaline.

Where the surface layer has been disturbed, the thin layer of volcanic ash between the 0 and A horizons is absent.

The A2 horizon has hue of 2.5Y or 10YR, value of 5 through 7 dry and 4 or 5 moist. The A&B horizon has hue of 2.5Y or 5Y, value of 6 or 7 dry and 4 through 6 moist, and chroma of 2 or 3. The structure is subangular blocky, platy, or prismatic with distinct wavy discontinuous clayey bands. The bands range in thickness from 1/16 inch to 3 inches and are on 10 to 40 percent of the matrix. The B3tca horizon has distinct lime veins and splotches.

WB-Wishbone-Caboose complex. This mapping

unit is on terraces. It is about 60 percent; Wishbone silt loam and 20 percent Caboose very fine sandy loam. Slopes range from 45 to 75 percent.

The soils occur in such an intricate pattern that it is not practical to map them separately. The unit is about 10 percent included areas of Artnoc soils, 10 percent Crash soils, small areas where slopes are short and range from 20 to 45 percent, and some areas where slopes are 75 to 110 percent.

This unit is used for woodland, wildlife habitat, and recreation. Capability subclass VIIe, wildlife group 3141; Wishbone soil in woodland group 3r6, Caboose soil in 3r9.

Planning the Use and Management of the Soils

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area-the soil. It may be used to fit the use of the land, including urbanization, to the limitations and potentials of the natural resources and the environment and to help avoid soil-related failures in uses of the land.

During a soil survey soil scientists, conservationists, engineers, and others keep extensive notes, not only about the nature of the soils but also about; unique aspects of behavior of these soils in the field and at construction sites. These notes include observations of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating to the kinds of soil and their productivity, potentials, and limitations under various uses and management. In this way field experience incorporated with measured data on soil properties and performance is used as a basis for predicting soil behavior.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for crops and pasture, range, woodland, and many nonfarm uses, including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses may be determined, soil limitations to these land uses may be identified, and costly failures in homes and other structures resulting from unfavorable soil properties may be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area, and on the environment. Both of these factors are closely related to the nature of the soil. Plans can be made to maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information useful in locating sources of sand and gravel, road fill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, trees and shrubs, and most other uses of land are influenced by the nature of the soil.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils ; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. This classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows

Class I soils have few limitations that restrict their use. No class I soils in this survey area.

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c*, to the class numeral, for example, IIIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty or stony; and *c*, used in only some

parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c,* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, range, woodland, wildlife habitat, or recreation.

The capability unit is identified in the description of each soil mapping unit in the section "Descriptions of the Soils." Capability units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIw-20 or IIIe-23.

Management by capability units

On the following pages, the capability units in the Boundary County Area are described and the use and management of the soils is suggested. Texture used in this section refers to the texture of the surface layer, unless otherwise stated. Also, unless otherwise stated, depth means depth to bedrock or some other kind of layer which restricts the root development of common plants. The available water capacity is given to a depth of 60 inches or to the depth of the restrictive layer, whichever is less.

The names of the soil series represented in each capability unit are mentioned in the description of that unit, but the listing of the series name does not necessarily indicate that all the mapping units of that series are in the same capability unit.

In the Boundary County Area, the capability units are set up and numbered within a system of capability classification that is used throughout the State of Idaho. Not all the capability units in this system are applicable, and for this reason, the numbering of the capability units is not consecutive in all cases.

To find the capability unit to which a given mapping unit has been assigned, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT IIw-20

This capability unit consists of moderately well drained and poorly drained soils of the Farnhamton and Ritz series. These soils are more than 60 inches deep. The surface layer is silt loam. Slopes are 0 to 5 percent. These soils are protected by a system of dikes, drainage ditches, and pumps. Permeability is moderate. The available water capacity is 11 to 13 inches, and the frost-free season ranges from 120 to 140 days. Runoff is slow, and the hazard of erosion is none or slight.

The soils in this capability unit are used for winter and spring wheat, barley, oats, hay, clover seed, and pasture.

Conservation practices needed for these soils are conservation cropping systems, land smoothing, field drainage ditches, minimum tillage, and crop residue management. Nitrogen and sulfur are needed for small grain, pasture, and hay.

An average cropping system is small grain for 5 to 7 years and grass-legume hay or pasture for 5 to 8 years. Clover for seed can be grown for 2 to 3 years instead of hay or pasture.

KENNETH E. REIRSGARD, area agronomist, and THOMAS I. WILSON, district conservationist, Soil Conservation Service, helped prepare this section.

CAPABILITY UNIT IIIe-23

This capability unit consists of soils of the Porthill and Rubson series. These soils are more than 60 inches deep. The surface layer is silt loam. Slopes are 0 to 12 percent. The soils are moderately well drained and well drained. Permeability is slow to moderate. Mean annual precipitation ranges from 20 to 28 inches. The available water capacity is 11 to 13 inches, and the frost-free season ranges from 110 to 140 days. Runoff is slow to medium, and the hazard of erosion is moderate.

The soils in this capability unit are used for wheat, oats, barley, hay, pasture, clover, alfalfa seed, and woodland.

Conservation practices needed for these soils to control erosion are conservation cropping systems, minimum tillage, contour farming, divided slopes, and crop residue management. Nitrogen and sulfur are needed for small grain and borated gypsum for alfalfa.

An average cropping system is winter or spring wheat, barley, or oats for 3 to 7 years and grass-legume hay or pasture for 5 to 8 years. Clover for seed can be grown for 2 or 3 years and small grain for 1 to 2 years.

CAPABILITY UNIT IVw-20

This capability unit consists of poorly drained soils of the Schnoorson and DeVoignes series. These soils are more than 60 inches deep. The surface layer is silty clay loam or mucky silt loam. Slopes are 0 to 1 percent. Most of these soils are protected by a system of dikes, drainage ditches, and pumps. Unprotected areas are subject to seasonal overflow from side streams and seepage from the Kootenai River. Permeability is moderately slow to slow. The available water capacity is 10 to 12 inches, and the frost-free season ranges from 120 to 140 days. Runoff is very slow, and there is no hazard of erosion. The water table is below a depth of 2 to 4 feet during the growing season.

The soils in this capability unit are used for spring wheat, oats, barley, pasture, and clover seed.

Conservation practices needed for these soils are land smoothing, field drainage ditches, minimum tillage, and crop residue management. Fall tillage and spring seeding are normal field operations. Nitrogen and sulfur are needed for small grain and pasture.

An average cropping system is continuous small grain for 5 to 7 years and grass or pasture or hay for 6 to 8 years. Clover for seed can be grown for 2 to 3 years instead of hay or pasture.

CAPABILITY UNIT IVw-21

Seelovers silt loam is the only soil in this capability unit. It is more than 60 inches deep. Slopes are 0 to 2 percent. The soil is poorly drained. Permeability is moderately slow. The available water capacity is 11

to 13 inches, and the frost-free season ranges from 80 to 110 days. Runoff is slow, and the hazard of erosion is none or slight. The water table is ponded or near the surface during spring runoff and is at a depth of 20 inches or more during the latter part of the growing season.

This soil is used for pasture, hay, oats, and woodland.

Conservation practices needed for this soil are land smoothing, field drainage ditches, and minimum tillage. Fall tillage and spring seeding are normal field operations. Nitrogen and sulfur are needed for small grain, pasture, and hay.

An average cropping system is hay or pasture for 6 to 8 years and oats for 1 or 2 years.

CAPABILITY UNIT IVw-22

Pywell muck is the only soil in this capability unit. It is more than 60 inches deep. Slopes are less than 1 percent. This soil is very poorly drained. It is protected by a system of dikes, drainage ditches, and pumps. Unprotected areas are subject to seasonal overflow from side streams, seepage, and springs. Permeability is moderate. Available water capacity is more than 12 inches, and the frost-free season is 80 to 110 days. Runoff is very slow or ponded, and there is no hazard of erosion. When the soil is dry, subsidence and cracks occur. The water table is below a depth of 20 inches during the growing season.

Conservation practices needed on this land are land smoothing, field drainage ditches, minimum tillage, and crop residue management. Fall tillage and spring seeding are common field operations. Nitrogen and sulfur are needed for small grain and pasture.

An average cropping system is continuous small grain.

CAPABILITY UNIT IVs-24

This capability unit consists of well drained soils of the Stien and Selle series. The surface layer is cobbly silt loam, gravelly silt loam, or fine sandy loam. Slopes range from 0 to 12 percent. Permeability is moderate to very rapid. Mean annual precipitation is 23 to 30 inches. The available water capacity is 3.5 to 8 inches, and the frost-free season is 90 to 140 days. Runoff is slow, and the hazard of erosion is slight to moderate.

The soils in this capability unit are used for grass-legume hay, pasture, winter and spring wheat, oats, barley, and woodland.

Tillage of the Stien soils is limited by surface gravel and cobbles.

Conservation practices needed for these soils are conservation cropping systems, minimum tillage, contour farming, and crop residue management. Nitrogen and sulfur are needed for small grain and pasture, and borated gypsum is needed for alfalfa.

An average cropping system is grass-legume hay or pasture for 6 to 8 years and small grain for 1 or 2 years.

CAPABILITY UNIT Vw-20

This capability unit consists of very poorly drained and poorly drained soils of the Pywell-DeVoignes complex. These soils have more than 16 inches of peat in the surface layer. Slopes are 0 to 1 percent. The available water capacity is more than 10 inches, and the frost-free season is 80 to 140 days.

Runoff is ponded or very slow, and there is no hazard of erosion. Outlets are hard to obtain. Effective rooting depth is more than 60 inches. A seasonal high water table is at or near the surface most of the time.

The soils in this capability unit are used for pasture, hay, woodland, and wildlife habitat.

There is limited grazing, and some hay is cut when the water table drops enough to support livestock and machinery late in summer.

CAPABILITY UNIT VIe

This unit consists of well drained soils of the Idamont, Pend Oreille, and Treble series. These soils are more than 40 inches deep. The surface layer is gravelly sandy loam, sandy loam, and silt loam. Slopes are 5 to 35 percent. Permeability is moderately rapid or moderate. The mean annual precipitation is 24 to 40 inches. The available water capacity is 3.5 to 10 inches, and the frost-free season is more than 70 days. Runoff is medium, and the hazard of erosion is moderate.

The soils in this capability unit are used mostly for woodland, wildlife habitat, and recreation.

CAPABILITY UNIT VIs

This capability unit consists of excessively drained to well drained soils of the Bane, Elmira, and Selle series. These soils are more than 60 inches deep. The surface layer is loamy fine sand, loamy sand, or fine sandy loam. Slopes are 0 to 20 percent. Permeability is rapid or very rapid. The available water capacity is 3 to 8 inches, and the frost-free season is more than 90 days. The mean annual precipitation is 20 to 28 inches. Runoff is very slow or slow, and the hazard of erosion is slight. Elmira soils are subject to soil blowing if unprotected. Bane soils are subject to channel changes with seasonal overflow.

The soils in this capability unit are used for woodland, wildlife habitat, and recreation.

CAPABILITY UNIT VIIe

This capability unit consists of well drained or moderately well drained soils of the Artnoc, Caboose, Crash, Idamont, Pend Oreille, Treble, and Wishbone series. These gravelly moderately coarse textured and medium textured soils are more than 40 inches deep. Slopes are generally 35 to 75 percent. Permeability is moderately rapid to moderately slow. The available water capacity is 3.5 to 13 inches, and the frost-free season is more than 70 days. Runoff is medium or rapid, and the hazard of erosion is severe. The mean annual precipitation ranges from 20 to 40 inches.

The soils in this capability unit have a cover of conifers, shrubs, forbs, and grasses. Density of cover and kinds of vegetative habitat types are dependent upon aspect. The driest and warmest aspect is usually on the southwest-facing slopes and the wettest and coldest on the north-facing slopes.

CAPABILITY UNIT VIIs

This capability unit consists of the miscellaneous land type Rock outcrop in complexes with Pend Oreille, Kriest, and Treble soils. Rock outcrop has little or no vegetation and has little or no value for farming

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

or woodland. Because of the rough surface and scarcity of vegetation, this land type is a very poor habitat for game animals. Its main value is for use as watershed and recreation.

The intermingled soils are well drained and are more than 40 inches deep. Slopes range from 5 to 65 percent. The mean annual precipitation ranges from 20 to 40 inches. The frost-free season is more than 70 days.

Permeability is moderate to moderately rapid. The available water capacity ranges from 3.5 to 8 inches. Runoff is medium or rapid, and the erosion hazard is severe.

These soils have a cover of conifers, shrubs, forbs, and grasses. Because of the intermingled Rock outcrop, these soils are difficult to manage for woodland or grazing.

Estimated Yields

Estimated yields for this survey area are shown in table 2. They are based on observations of soil scien-

tists who surveyed in the area and information furnished by farmers, by the county extension agent, by personnel of the local office of the Soil Conservation Service and the Agricultural Stabilization and Conservation Service, from agricultural scientists of the University of Idaho, and by available census data. If information for a particular soil was not available, estimates were made on the basis of information pertaining to a similar soil.

The farmers obtaining yields given in table 2 used a continuous grain recrop system and stubble mulch tillage. In addition, minimum tillage was o a the contour or across slope where applicable. Nitrogen and sulfur are commonly used on grain crops, and borated gypsum is used on alfalfa. Attention is given to the control of weeds, disease, and insects and to timeliness of planting and harvesting.

The crop yields are averages expected over a period of years for varieties of crops commonly grown in the area. Thus, yields higher than those given in table 2 are not uncommon. They can be obtained it favorable seasons, especially if heavy fertilization is practiced. Expected yields may change greatly in the future as new crop varieties and cultural practices are introduced, or as new plant diseases or insect pests appear.

Woodland

Forest covered the entire upland area when the first settlers came to Boundary County. Cutting timber began about 1890. Some of the high terraces were cleared for farming. Woodland is continually cleared for pasture and cultivated crops.

Presently, grand fir, Douglas-fir, and western larch are the leading species harvested. Western white pine, lodgepole pine, western redcedar, western hemlock, and pondorosa pine are also important species. The woodland in this survey area is owned and managed by the Idaho State Forestry Department, the Bureau of Indian Affairs, and private individuals.

In addition to its value as a source of wood products, the woodland provides grazing for a large number of livestock and also provides habitat for wildlife. It is the source of much of the water that makes farms, ranches, and urban communities possible in the lowlands. The cover of trees, shrubs, and herbaceous plants helps prevent damaging floods and reduces sedimentation in reservoirs. Furthermore, wooded areas have great scenic beauty. They attract many visitors and have a high recreational value.

Kinds of trees

Soils vary in their potential to produce wood fiber. Depth, fertility, and available water capacity, all of which are influenced by elevation, aspect, and climate, determine the kinds of trees that can be expected on any site. Available water capacity and the depth to the rooting zone are of major importance. Elevation and aspect are of particular importance to the kinds of woodland habitat types that occur in the Boundary County Area.

The western hemlock habitat type (4) occupies the coolest and the more moist aspects at the lower elevations. The western redcedar, grand fir, and Douglas-fir habitat types range from the moist to the drier regimes. Each species varies in abundance on different aspects and altitudinal ranges and may be lacking in some habitat types. Major broadleaf trees are black cottonwood, quaking aspen, thinleaf alder, paper birch, and Rocky Mountain maple.

The western hemlock-Myrtle pachistima habitat type is common in the Boundary County Area. Western white pine, western larch, western redcedar, and grand fir make up a substantial part of the stand.

The western redcedar-Myrtle pachistima habitat type is mainly in peripheral areas where the western hemlock-Myrtle pachistima type occurs. The major species are western redcedar, western white pine, western larch, Douglas-fir, and grand fir.

The grand fir-Myrtle pachistima habitat type occurs on the warmer and drier, southeasterly and southwesterly aspects. Other associated species found on the grand fir-Myrtle pachistima habitat type are Douglas-fir, western white pine, western larch, ponderosa pine, and lodgepole pine.

Douglas-fir grows on soils that are too dry for grand fir. It grows in association with ponderosa pine on southerly and southwesterly aspects.

Black cottonwood, quaking aspen, and paper birch grow on soils that are wet or have a high water table much of the growing season. The cottonwood habitat type is associated with wet meadows. Western redcedar, Douglas-fir, lodgepole pine, and western larch are at the marginal edge of the wet meadows.

The western redcedar-western hemlock-devilsclub habitat type is associated with wet organic soils and wet meadows. The trees root on downed logs and on mounds and are subject to windthrow before they reach maturity. The overstory is mainly western redcedar, western hemlock, paper birch, black cottonwood, and scattered Engelmann spruce and subalpine fir. The understory is an abundance of shrubs, chiefly Rocky Mountain maple, thinleaf alder, quaking aspen, and devilsclub.

Yields

The potential productivity of a soil for a specified tree species is expressed as site index. Site index is the average height, in feet, of the dominant and codominant trees of a given species at a specified age. These are the taller trees, the crowns of which form the general level of the woodland canopy and occasionally extend above it. In this survey area, the index age for ponderosa pine and Douglas-fir is 100 years. For grand fir and western white pine, it is 50 years. Site indexes can also be used to assess the quality of stands that are less than 50 years or more than 100 years old.

Site class represents a grouping of site indexes within a defined range for a species, or a combination of species. The relationship between the site class and site index for ponderosa pine, Douglas-fir, grand fir, and western white pine is useful in understanding the quality of a site. The quality of a site, or the site class, is expressed as excellent, good, fair, poor, and very poor.

The following tabulation indicates the site class

By MELVIN R. CARLSON, woodland conservationist, and DENNIS K. FROEMING, range conservationist.

and the site index range, in feet, for ponderosa pine and Douglas-fir at 100 years of age

	Site index range
Excellent	113 or more
Good	99 to 112
Fair	85 to 98
Poor	71 to 84
Very poor	70 or less

The next tabulation indicates the site class and the site index range, in feet, for grand fir and western white pine at 50 years of age:

	Site index range
Excellent	66 or more
Good	56 to 65
Fair	46 to 55
Poor	36 to 45
Very poor	35 or less

Average yields that can be expected per acre from fully stocked, even-aged, unmanaged stands of ponderosa pine (5) on soils of various site indexes are shown in figure 7. The information in figure 7 can also be used to determine average yields per acre for Douglas-fir because the relation between site index and yield is similar for the two species. Yields shown in figure 7 are for trees 11.6 inches in diameter at breast height and larger.

Average yields per acre from fully stocked, even-aged, unmanaged stands of western white pine (4) are shown in figure 8. The information in this figure can also be used to determine average yields per acre for grand fir. Yields in figure 8 are for trees 12.6 inches in diameter at breast height and larger.

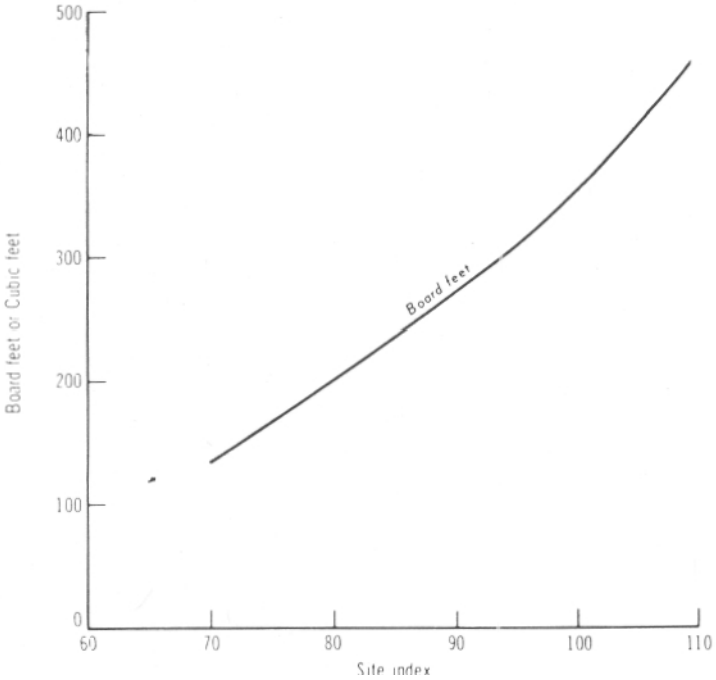

Figure 7.-Average annual yield in board feet (Scribner rule) per acre for even-aged, fully stocked, unmanaged stands of ponderosa pine at 100 years of age.

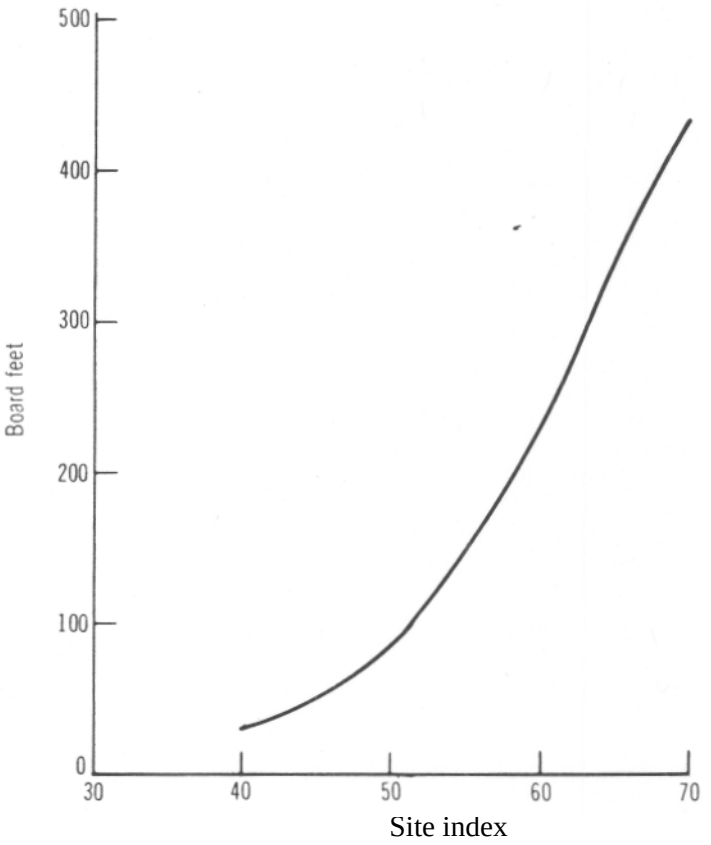

Figure 8.-Average annual yield in board feet (Scribner rule) per acre for even-aged, fully stocked, unmanaged stands of western white pine at 80 years.

Production of wood crops

The woodland soils of the Boundary County Area have been grouped according to their suitability for trees. Each group consists of soils that produce a similar kind of wood crops, need similar management, and have about the same productivity. Some of the woodland in the survey area has grazing potential for livestock. The name of the soils in each group is listed in the "Guide to Mapping Units" at the back of this survey.

For each group, the dominant species is given and the productivity ratings are based on site index. The value of tree species varies according to changes in the demand for woodland products, the condition of the trees that make up a stand, and the needs and desires of owners. No attempt, therefore, has been made to list the species of trees in order of preference.

Important parts of the descriptions of the woodland groups are adjective ratings for risk of competition from other plants, hazard of seedling mortality, limitations to use of equipment, and hazard of erosion. These ratings are expressed in terms of *slight, moderate,* or *severe.* The following explanations of these ratings apply to the descriptions of all woodland groups.

Plant competition is rated on the basis of the degree to which unwanted plants invade openings in the tree

stand. A rating of *slight* means unwanted plants present no special problem; *moderate* means the invaders delay but do not prevent establishment of a normal, fully stocked stand; and *severe* means trees cannot regenerate naturally because of competition from invaders.

Seedling mortality refers to the expected degree of mortality of planted seedlings as influenced by the soil and lack of moisture. A rating of *slight* indicates an expected loss of less than 25 percent of the planted seedlings; *moderate* indicates a loss of 25 to 50 percent of the seedlings; and *severe* indicates a loss of more than 50 percent of the seedlings.

Equipment limitations are rated on the basis of soil characteristics that restrict or prohibit the use of equipment commonly used in tending and harvesting the trees. In the Boundary County Area soil characteristics that have the most limiting effects are texture, drainage, slope, and stoniness. A rating of *slight* means there is little or no restriction in the kind of equipment or the time of year it is used; *moderate* means that the use of equipment is restricted by one or more soil properties and that some kinds of equipment would injure tree roots or damage soil structure; and *severe* means that equipment use is severely restricted either as to kind of equipment which can be used or season of use.

Erosion hazard refers to the potential hazard of soil losses in woodland if the plant cover is disturbed or destroyed. The hazard is *slight* where problems of erosion control are minimal. *Moderate* means that some attention must be given to prevent unnecessary soil erosion; *severe* means that intensive treatments and specialized equipment must be used and that methods of operation must be planned to minimize deterioration of the soils.

Production of forage

The native herbage produced by understory species is available to livestock and wildlife. The :herbage provides feed for livestock late in spring, in summer, and in fall. Wildlife depend upon the native herbage for most of their food supply.

In open woodlands, understory species within reach of the grazing animal are also those which provide the most soil protection, prevent soil erosion, and maintain watershed and recreational values.

In uses of all resources, there are interactions among the users; some complement and some have an adverse effect. Where livestock grazing is managed, it is often beneficial to wildlife, and when improperly managed it is a detriment to all uses.

As a forest grows and matures, the over story closes, allowing less sunlight to reach the forest door for use by understory species. The amount of sunlight reaching the forest floor has a great effect on the understory growth, the herbage production, and the species composition. Light intensity on the forest floor is related to the density of the tree canopy. A dense canopy reduces the amount of sunlight to a degree that the quality and quantity of herbage is not sufficient to make grazing economical.

For planning and management purposes three canopy classes have been designated. Sparse is 0 to 35 percent canopy; medium, 35 to 60 percent canopy; and dense, more than 60 percent canopy.

The woodland suitability groups which have a grazing potential in an unmanaged condition include the following woodland habitat types : Douglas-fir-snowberry, Douglas-fir-pinebark, and Douglas-fir-pinegrass.

When the forest canopy of the other habitat types recognized in the survey is opened by logging, fire, and other disturbances, there are temporary increases in understory herbage usable by livestock and wildlife.

There are other wet grazing areas in the Boundary County Area, which are not forested. These wet meadows consist of wet soil areas of the DeVoignes, Pywell, and Schnoorson soils and nonforested areas of the Seelovers soils. These soils are wet most of the growing season. The annual precipitation has little or no effect on the kind and amount of vegetation because of a high water table.

Generally a stream flows through these meadows, but in some places, springs rise on nearly level soils causing yearlong saturation. On the outer edges of the meadow, the soils dry late in summer.

The plant community is complex. It is usually dominated by water tolerant grasses and sedges. Plants are high in density and consist of 60 to 90 percent grasses and sedges, 10 to 15 percent forbs, and less than 10 percent shrubs. The edges of these wet meadows have inclusions of the western redcedar-western hemlock-devilsclub habitat type.

Average annual yields in native condition vary from 3,000 pounds of air-dry herbage per acre in unfavorable years to 4,000 pounds per acre in favorable years.

Production can be improved on parts of these meadows. Drainage, renovation, seeding, and fertilization are feasible under some conditions.

Woodland suitability groups

The soils of Boundary County Area have been assigned to 15 woodland groups, according to their potential for production of wood crops and woodland forage. Each group is identified by a symbol, the connotation of which can be useful in broad resource planning.

The first element in the symbol, a numeral, indicates the woodland suitability class. It expresses a site quality ranging from 1 to 5 for an indicator tree species. Number 1 is the best site, and number 5 the poorest.

The second element in the symbol, a letter, indicates the subclass. Subclasses are based on selected soil characteristics that cause moderate or severe hazards or limitations or significantly affect woodland use and management.

The letter *w* indicates excessive wetness. These are soils in which excessive water, either seasonal or year long, significantly limits woodland management or use. The soils have restricted drainage or a high water table or are subject to overflow.

The letter *d* indicates restricted rooting depth. These

soils are shallow over bedrock, a hardpan, or other layers that restrict roots.

The letter *s* indicates sandy soils. These soils are droughty. They normally have less than 0.10 inch of available water per inch of soil and normally are low in plant nutrients.

The letter *f* indicates fragmental or skeletal soils. These soils have an excessive content of rock fragments over 2 millimeters in size and less than 0.10 inch of available water per inch of soil to a depth of 12 inches.

The letter *r* indicates steep slope.

The letter *o* indicates slight or no limitations.

The last part of the symbol, another number, represents the woodland habitat type, as used in the statewide system of numbering (3). The types, by number, recognized in the Boundary County Area are 6-Douglas-fir-snowberry, 7-Douglas-fir-ninebark, 8-Douglas-fir-pinegrass, 9-grand fir-Myrtle pachistima, 10-western redcedar-Myrtle pachistima, 11-western hemlock-Myrtle pachistima, 14-cottonwood, and 16-western redcedar-western hemlock-devils club.

The woodland suitability groups are described on the pages that follow. All soils in a specified group are enough alike to have similar productivity and to respond to similar use and management.

WOODLAND SUITABILITY GROUP 1d10

Porthill silt loam is the only soil in this group. It is a nearly level to moderately sloping, very deep, moderately well drained soil on high glaciolacustrine terraces. Slopes range from 0 to 12 percent. Permeability is slow. Runoff is medium. Available water capacity is 11 to 13 inches.

This soil supports the western redcedar-Myrtle pachistima habitat type. Western redcedar, western larch, western white pine, grand fir, Douglas-fir, and ponderosa pine are the dominant trees. Ponderosa pine grows as individual trees and in scattered patches and is only a minor part of the stand. The understory is chiefly twin flower, thimbleberry, false Solomonseal, princess-pine, and violet. Timber production is excellent. The site index for western white pine is 68. A fully stocked unmanaged stand at the age of 80 years yields about 31,260 board feet per acre. The average annual growth is about 390 board feet per acre.

The erosion hazard is moderate. Roads and skid trail locations must be given attention to prevent unnecessary erosion in the ravines and hilly areas.

Equipment limitations, seedling mortality, and the windthrow hazard are slight. Logging operations are best during dry summer months or when the soils are covered with snow. The soils are soft when wet. Plant competition is moderate. Good harvesting methods and site preparation are needed to regenerate desired tree species. Roots are somewhat restricted by the compact subsoil and the strongly calcareous substratum.

This woodland suitability group under natural conditions furnishes good cover for white-tailed deer and grouse. Forage values for wildlife and livestock are very low.

WOODLAND SUITABILITY GROUP 1f8

Stien cobbly silt loam is the only soil in this group. It is a very deep, well drained soil on glacial moraines. Slopes range from 0 to 12 percent. Permeability is moderately rapid. Available water capacity is 3.5 to 4.5 inches.

This soil supports the Douglas-fir-pinegrass habitat type. Lodgepole pine, ponderosa pine, and western larch also grow on this soil. Lodgepole pine reproduces in very dense stands as a result of disturbance by fire. Timber production is excellent. The average site index for Douglas-fir is 120. A fully stocked unmanaged stand of Douglas-fir at the age of 80 years yields about 25,000 board feet per acre. The average annual growth is about 310 board feet per acre.

Equipment limitations and the hazard of erosion are slight. Seedling mortality and plant competition are moderate. The invasion of shrubs and forbs can delay restocking, but competition is not sufficient to prevent adequate natural restocking. The windthrow hazard is slight even though root growth is somewhat restricted by the very low available water capacity in the lower part of the subsoil and in the substratum. Road cuts and fills are difficult to revegetate as a result of the coarse fragments and the very low available water capacity of the substratum. The soil has a potential for woodland grazing. Understory species include pinegrass, little whortleberry, bearberry, white spirea, buckwheat, rose, buffaloberry, and dwarf juniper.

As the canopy is opened by logging, fire, disease, or insects, the understory vegetation becomes more abundant. Pinegrass, sedge, bearberry, Oregongrape, and a variety of other forbs make up an important percent of the total herbage.

The understory has a potential to produce an annual yield of 400 to 700 pounds of herbage per acre if the canopy is sparse, 250 to 650 if it is medium, and 30 to 300 pounds of herbage per acre if it is dense.

Pinegrass is the key management species. About 35 to 40 percent of the understory vegetation produced provides forage for cattle and wildlife.

WOODLAND SUITABILITY GROUP lol0

In this group are soils of the Idamont and Selle series. These are nearly level to moderately steep, very deep, well drained soils on sandy plains and glacial mountainsides capped by volcanic ash. The surface layer is fine sandy loam or silt loam. Idamont soils have slopes of 35 percent. Selle soils have slopes of 0 to 7 percent. Permeability is moderate or very rapid. Runoff is medium to very slow. Available water capacity is 6 to 10 inches.

These soils support the western redcedar-Myrtle pachistima habitat type. Western redcedar, western white pine, Douglas-fir, grand fir, western larch, and lodgepole pine are the dominant trees. The understory is chiefly Myrtle pachistima, twin flower, thimbleberry, false Solomonseal, princess-pine, and violet. Timber production is excellent. The site index for western white pine is 66. A fully stocked unmanaged stand of trees at the age of 80 years yields about 28,000 board feet per acre. The average annual growth is about 350 board feet per acre. Equipment limitations, seedling mortality, plant competition, the hazard of erosion, and the windthrow hazard are slight.

This woodland suitability group under natural conditions furnishes good cover for white-tailed (leer and grouse. Forage values for wildlife and livestock are very low.

WOODLAND SUITABILITY GROUP 1r10

In this group are soils of the Artnoc and Idamont series. These are steep and very steep, very deep, well drained and moderately well drained soils on la custrine terraces and glacial mountainsides capped by volcanic ash. Slopes range from 35 to 75 percent. The surface layer is silt loam. Permeability is moderately slow or moderate. Runoff is medium to rapid. Available water capacity is 8 to 13 inches.

These soils support the western redcedar-Myrtle pachistima habitat type. Western redcedar, western white pine, Douglas-fir, grand fir, western larch, and lodgepole pine are the dominant trees. The understory is mainly Myrtle pachistima, twin flower, thimbleberry, false Solomonseal, princess-pine, and violet. Timber production is excellent. The site index for western white pine is 66. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 28,000 board feet per acre. The average annual growth is about 350 board feet per acre per year.

Equipment limitations are severe because of slope. Jammer and winch logging is well suited to the very steep slopes. Plant competition, seedling mortality, and the windthrow hazard are slight. The erosion hazard is severe. Sedimentation can be expected from roads, skid trails, and other disturbed areas. Cut slopes and fills cave and slip on these soils. Roads should be constructed on gentle grades. After logging, these soils must be properly protected from erosion by surface drainage, proper ditching, and suitable water barriers on skid trails and roads.

This woodland suitability group under natural conditions furnishes good cover for a large variety of wildlife species. Forage values for wildlife and livestock are very low.

WOODLAND SUITABILITY GROUP loll

In this group are soils of the Rubson and Pend Oreille series. These nearly level to moderately steep, very deep, well drained soils are on high lacustrine terraces and glaciated mountain slopes. The surface layer is silt loam or sandy loam. The Rubson soils have slopes of 0 to 12 percent. The Pend Oreille soils have slopes of 5 to 35 percent. Permeability is moderate. Available water capacity is 6 to 12 inches.

These soils support the western redcedar-Myrtle pachistima habitat type. Western hemlock, western redcedar, western white pine, grand fir, western larch, Douglas-fir, lodgepole pine, and ponderosa pine are the dominant trees. Ponderosa pine occurs as individual trees, or in scattered patches, and is only a minor species in this woodland suitability group. The understory is mainly Myrtle pachistima, princess-pine, goldthread, twin flower, and violet. Timber production is excellent. The site index for western white pine is 70. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 34,600 board feet per acre. The average annual growth is about 430 board feet per acre per year.

Equipment limitations are slight. Logging is possible the year round except during spring runoff when these soils are wet. Seedling mortality and the windthrow hazard are slight. Plant competition is slight to moderate because of the invasion of forbs and shrubs, but this competition is not sufficient to prevent adequate restocking. The hazard of erosion is slight or moderate.

This woodland suitability group under natural conditions furnishes good cover for a large variety of wildlife species. Forage values for wildlife and livestock are very low.

WOODLAND SUITABILITY GROUP lrll

In this group are soils of the Pend Oreille and Crash series. These are steep and very steep, very deep, well drained and moderately well drained soils on glaciated mountain slopes and lacustrine terrace slopes. Slopes are 35 to 75 percent. The surface layer is sandy loam or silt loam. Permeability is moderate or moderately slow. Runoff is rapid. Available water capacity is 6 to 13 inches.

These soils support the western hemlock-Myrtle pachistima habitat type. Western hemlock, western redcedar, western white pine, grand fir, western larch, Douglas-fir, and lodgepole pine are the dominant trees. The understory is mainly Myrtle pachistima, twin flower, wintergreen, spring beauty, huckleberry, false Solomonseal, and princess-pine. Timber production is excellent. The site index for western white pine is 70. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 34,600 board feet per acre. The average annual growth is about 430 board feet per acre per year.

Equipment limitations are severe because of slope. Roads should be constructed on contours and gentle grades. The hazard of erosion is severe. Sedimentation can be expected from roads, skid trails, and other disturbed areas. Deeply cut slopes will cave and slip out and should be avoided. Maximum spacing between roads is desirable. Jammer and winch logging is best suited to steep slopes. Seedling mortality and the windthrow hazard are slight. Plant competition is slight to moderate as a result of an invasion of forbs and shrubs. This competition is not sufficient to prevent adequate stocking.

This woodland suitability group under natural conditions furnishes good cover for a large variety of wildlife species. Forage values for wildlife and livestock are very low.

WOODLAND SUITABILITY GROUP 1w14

In this group are soils of the Farnhamton and Ritz series. These are nearly level to gently sloping, very deep, moderately well drained to poorly drained soils on natural levees and low terraces on the Kootenai River flood plain. The surface layer is silt loam. Most of these soils are protected from flooding by dikes in summer. The water table generally fluctuates between the surface and a depth of 4 feet in spring and early in summer. Available water capacity is 11 to 13 inches.

These soils support a cottonwood habitat type. Black cottonwood is the dominant tree, and it is used for specialty wood products. Invading these soils are Douglas-fir, western redcedar, paper birch, and thinleaf alder. These soils have a good potential for agri-

cultural use and are not important for timber production. When western redcedar and associated species grow in fully stocked stands on these soils, the productivity is excellent. The site index for white pine averages 66. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 28,000 board feet per acre. The average annual growth is about 350 board feet per acre per year. Most of these soils are cultivated.

Equipment limitation is severe because of the high water table. This delays harvests. Seedling mortality and the hazards of erosion and windthrow are slight. Plant competition is moderate to severe. Shrubs and black cottonwood will prevent full restocking of coniferous trees. The potential for livestock grazing and use as wildlife habitat is very good.

The potential understory vegetation is dominated by water tolerant species of grass, grasslike plants, forbs, and shrubs.

The plant density is high and grasses and grasslike plants make up 50 to 75 percent of the vegetation. About 15 to 25 percent is forbs, and 10 to 25 percent is shrubs. The major understory species include Kentucky bluegrass, quackgrass, reed canarygrass, miscellaneous sedges, cinquefoil, goldenpea, goldenrod, false hellebore, willow, thinleaf alder, Rocky Mountain maple, redosier dogwood, and pyramidal spirea.

The understory vegetation has a potential to produce a total annual yield of herbage per acre of 1,500 to 3,000 pounds if the canopy is sparse, 700 to 1,500 pounds if it is medium, and 50 to 500 pounds if the canopy is dense.

These soils are suitable for mechanical treatment to improve production. Drainage, renovation, seeding, and fertilization are feasible. About 35 to 40 percent of the understory vegetation production provides forage for cattle and wildlife.

WOODLAND SUITABILITY GROUP 1w16

Seelover silt loam is the only soil in this group. This nearly level, very deep, poorly drained soil occurs along streams. Slopes are less than 2 percent. Permeability is moderately slow. Runoff is slow to very slow. Available water capacity is 11 to 13 inches. The water table is at or near the surface part of the year, and the soil is subject to overflow.

This soil supports the western hemlock-devilsclub habitat type. Western hemlock, western redcedar, western white pine, western larch, and grand fir are the dominant trees. Scattered Engelmann spruce, subalpine fir, and black cottonwood are also present. The understory is devilsclub, thinleaf alder, Rocky Mountain maple, paper birch, pyramidal spirea, and sedge. There are some open meadows. Timber production is excellent. The site index for western white pine is 70. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 34,600 board feet per acre. The average annual growth is about 430 board feet per acre per year.

Equipment limitation is severe as a. result of the high water table. The best time to log is when the soil is frozen. Seedling mortality is slight. Plant competition is moderate because of the invasion of forbs, sedges, and shrubs. This competition is not sufficient to prevent adequate restocking. Root development is restricted by a high water table. The windthrow hazard is moderate because of the soft soil condition and shallow root system.

This woodland suitability group under natural conditions has very low forage values for livestock and wildlife.

WOODLAND SUITABILITY GROUP 1s6

Bane loamy fine sand is the only soil in this group. This gently sloping soil is very deep and excessively drained. It is on alluvial fans at the mouth of canyons that are generally on the western side of the Kootenai River flood plain. Slopes are 2 to 8 percent. This soil is subject to stream channel displacement. Permeability is rapid. Runoff is slow. Available water capacity is 3 to 5 inches, but is supplemented by the spring runoff. Cool air temperatures help the soil retard evaporation.

This soil supports the Douglas-fir-snowberry habitat type. Douglas-fir and ponderosa pine are the dominant trees. Productivity is variable as a result of stream channel changes. The site index is 66. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 28,000 board feet per acre. The average annual growth is about 350 board feet per acre per year.

Equipment limitations are slight, and seedling mortality is moderate. Plant competition is moderate as a result of the invasion of shrubs and other understory plants, but does not prevent adequate restocking. Root development is not restricted. The windthrow hazard and the hazard of erosion are slight. Significant amounts of understory plants furnish food for wildlife.

The potential understory vegetation consists of about 30 to 50 percent shrubs, 25 to 50 percent grasses, and 10 to 20 percent forbs. The understory is mainly snowberry, white spirea, Woods rose, Oregongrape, pinegrass, bluebunch wheatgrass, lupine, strawberry, cinquefoil, and yarrow.

The understory vegetation has a potential to produce a total annual yield of 250 to 400 pounds of herbage per acre if the canopy is sparse, 150 to 350 pounds if it is medium, and 50 to 200 pounds if the canopy is dense. A dense canopy can be expected for a mature stand in this woodland suitability group.

Pinegrass is the key management species because of its abundance in the understory when the canopy is sparse. About 35 to 40 percent of the understory vegetation production provides forage for cattle and wildlife.

WOODLAND SUITABILITY GROUP 2o7

In this group are soils of the Treble series that have slopes of 5 to 35 percent. These deep, well drained soils are on glacial mountain slopes and are intermingled with Rock outcrop in some areas. The surface layer is gravelly sandy loam. Permeability is moderately rapid. Runoff is slow. Available water capacity is 3.5 to 6 inches.

This soil supports a Douglas-fir-ninebark habitat type. Douglas-fir and ponderosa pine are the dominant trees. The average site index for ponderosa pine is 102. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 26,000 board feet per

acre. The average annual growth is about 325 board feet per year per acre.

Equipment limitations and the windthrow hazard are slight. Seedling mortality, plant competition, and the hazard of erosion are moderate. The invasion of shrubs, forbs, and other understory is sufficient to delay adequate restocking. There is a potential for wildlife and livestock grazing under natural conditions.

The potential understory vegetation is about 36 to 60 percent shrubs, 15 to 25 percent forbs, and 25 to 40 percent grasses. The major understory species are ninebark, white spirea, snowberry, serviceberry, Woods rose, yarrow, arnica, lupine, strawberry, pinegrass, elk sedge, and mountain brome.

The understory vegetation has the potential to produce a total annual yield of 800 to 1,500 pounds of herbage per acre if the canopy is sparse, 500 to 1,200 pounds if it is medium, and 200 to 800 pounds if the canopy is dense. A medium to dense canopy can be expected for a mature stand in this woodland suitability group.

Pinegrass is the key management species because of the abundance under sparse cover. About 15 to 25 per cent of the understory vegetation production provides forage for cattle and wildlife.

WOODLAND SUITABILITY GROUP 2r7

In this group are soils of the Treble series that have slopes of 35 to 65 percent. These deep, well drained soils are on glaciated mountain slopes and are intermingled with Rock outcrop. The surface layer is gravelly sandy loam. Runoff is slow. Permeability is moderately rapid. Available water capacity is 3.5 to 6 inches.

This soil supports the Douglas-fir-ninebark habitat type. Douglas-fir and ponderosa pine are the dominant trees. Timber production is good. The site index for ponderosa pine is 102. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 26,000 board feet per acre. The average annual growth is about 325 board feet per acre.

Equipment limitation is severe as a result of slopes and, in some areas, Rock outcrop. Jammer and winch logging are best suited to this soil. Seedling mortality is moderate. Plant competition is moderate and will delay natural regeneration and planted seedlings because of the invasion of brush and forb species. The windthrow hazard is slight, and the hazard of erosion is severe. Deeply cut slopes cave and slip out. Maximum spacing between roads is desirable. Severe sedimentation can be expected from roads, skid I rails and other disturbed areas. Roads should be constructed on gentle grades.

The potential understory vegetation is about 35 to 60 percent shrubs, 15 to 25 percent forbs, and 25 to 40 percent grasses. The major understory species are ninebark, white spirea, snowberry, serviceberry, Woods rose, yarrow, arnica, lupine, strawberry, pinegrass, elk sedge, and mountain brome.

The understory vegetation has the potential to produce a total annual yield of 800 to 1,500 Pounds of herbage per acre if the canopy is sparse, 500 to 1,200 pounds if the canopy is medium, and 200 to 800 pounds if the canopy is dense. A medium to dense canopy can be expected for a mature stand in this woodland suitability group.

Pinegrass is the key management species because of its abundance under sparse cover. There is a potential for wildlife and livestock grazing under natural conditions. About 15 to 25 percent of the understory vegetation production provides forage for cattle and wildlife.

WOODLAND SUITABILITY GROUP 3r6

In this group are soils of the Wishbone series. These are steep, well drained soils on lacustrine terraces. Slopes are 20 to 65 percent. Runoff is rapid. Permeability is moderate. Available water capacity is 11 to 13 inches.

These soils support the Douglas-fir-snowberry habitat type. Douglas-fir and ponderosa pine are the dominant trees. Timber production is fair. The site index for ponderosa pine is 89. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 18,500 board feet per acre. The average annual growth is about 230 board feet per acre per year.

Equipment limitation is moderate on slopes of 20 to 35 percent and severe on slopes of 35 to 65 percent. Jammer and winch logging are suited to these steep slopes. The hazard of erosion is severe. Sedimentation can occur from roads, skid trails, and other disturbed areas. Roads should be constructed to conform to the shape of the slope and should be constructed on gentle grades. Cut slopes will cave and slip out. Adequate drainage, proper ditching, and suitable water barriers are needed to control erosion. Seedling mortality is moderate. The soils are dry for 45 or more consecutive days in summer. Plant competition is moderate as a result of the invasion of shrubs and forbs.

Trees, shrubs, and other understory species have a potential for wildlife and limited livestock grazing under natural conditions.

The potential understory vegetation is about 30 to 50 percent shrubs, 25 to 50 percent grasses, and 10 to 20 percent forbs. The major understory species include snowberry, wild rose, white spirea, Oregongrape, lupine, yarrow, cinquefoil, pinegrass, and bluebunch wheatgrass.

The understory vegetation has a potential to produce a total annual yield of 250 to 400 pounds of herbage per acre if the canopy is sparse, 150 to 350 pounds if it is medium, and 50 to 200 pounds if the canopy is dense. Pinegrass is the key management species because of its abundance in the understory. About 35 to 40 percent of the understory vegetation production provides forage for cattle and wildlife.

WOODLAND SUITABILITY GROUP 3o9

In this group are soils of the Kriest series that have slopes of 5 to 35 percent. These deep, well drained soils are on glaciated mountain slopes thinly capped by volcanic ash. They are 40 to 60 inches deep to weathered granite and are intermingled with Rock outcrop. The surface layer is gravelly sandy loam. Runoff is slow. Permeability is moderately rapid. Available water capacity is 3.5 to 5 inches.

These soils support the grand fir-Myrtle pachistima habitat type. Grand fir, Douglas-fir, ponderosa pine, western larch, lodgepole pine, and western white pine

are the dominant trees. Grand fir grows readily in the shade and restocks open areas more rapidly than other trees. Timber production is fair. The site index for western white pine is 55. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 12,200 board feet per acre. The average annual growth is about 152 board feet per acre per year.

Equipment limitation and the windthrow hazard are slight. Seedling mortality is moderate as a result of the available water capacity. Plant competition is moderate because of the invasion of shrubs and forbs. This competition is not sufficient to prevent adequate restocking. The hazard of erosion is moderate.

The potential for wildlife and livestock grazing under natural conditions is very low.

WOODLAND SUITABILITY GROUP 3r9

In this group are soils of the Kriest and Caboose series. These are deep and very deep, well drained soils on lacustrine terraces and glaciated mountain slopes thinly capped by volcanic ash. Slopes are 35 to 75 percent. The surface layer is very fine sandy loam or gravelly sandy loam. Runoff is medium to rapid. Permeability is moderate or moderately rapid. Available water capacity is 3.5 to 13 inches.

These soils support the grand fir-Myrtle pachistima habitat type. Grand fir, Douglas-fir, ponderosa pine, western larch, lodgepole pine, and western white pine are the dominant trees. Grand fir grows readily in the shade and restocks open areas more rapidly than other species on these soils. Timber production is fair. The site index for western white pine is 55. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 12,200 board feet per acre. The average annual growth is about 150 board feet per acre per year.

Equipment limitation is severe. Traction is poor on the Caboose soils when they are wet, and they become badly rutted. The hazard of erosion is :severe. Severe sedimentation can be expected from roads, skid trails, and other disturbed areas. Roads should be constructed to conform to the shape of the slope and should be constructed on gentle grades. Cut slopes on the Caboose soils will cave and slip out. Jammer and winch logging is best suited to slopes of 35 to 65 percent. Seedling mortality is moderate to slight as a result of the available water capacity. Plant competition is moderate because of the invasion of shrubs and forbs. This competition is not sufficient to prevent adequate restocking. The windthrow hazard is slight.

The potential for wildlife and livestock grazing under natural conditions is very low.

WOODLAND SUITABILITY GROUP 4s8

In this group are soils of the Elmira series. These are nearly level to hilly, very deep, excessively drained soils on sandy terraces and dunes. Slopes are 0 to 20 percent. The surface layer is loamy sand. Runoff is very slow. Permeability is rapid. Available water capacity is 3.5 to 5 inches.

These soils support a Douglas-fir-pinegrass habitat type. Douglas-fir and ponderosa pine are the dominant trees. Timber production is fair. The site index for ponderosa pine is 84. A fully stocked, unmanaged stand of trees at the age of 80 years yields about 14,720 board feet per acre. The average annual growth is about 185 board feet per acre per year.

Equipment limitation is moderate as a result of poor traction. Logging when the soils are wet or snow covered is recommended. Seedling mortality is severe because of the low available water capacity. Plant competition is slight and natural restocking takes place rapidly when seed source is available. The windthrow hazard is moderate. Root development is restricted by lack of available moisture. The hazard of soil blowing is moderate because of the loose sandy characteristic of the soil. Cut slopes tend to cave and blow out. There is a natural grazing potential for livestock and wildlife.

The potential understory vegetation is about 50 percent grasses, 40 percent shrubs, and 10 percent forbs. The major understory species include pinegrass, bluebunch wheatgrass, Idaho fescue, Oregongrape, snowberry, chokecherry, serviceberry, arnica, yarrow, lupine, and sedge.

The understory vegetation has the potential to produce a total annual yield of 550 to 800 pounds of herbage per acre if the canopy is sparse, 400 to 600 pounds if the canopy is medium, and 150 to 450 pounds if the canopy is dense. A medium canopy can be expected for a mature stand on these soils.

Bluebunch wheatgrass is the key management species because of the abundance in the understory. About 30 to 40 percent of the understory vegetation production provides forage for cattle and wildlife.

Wildlife

Soil suitability is one of the important factors necessary to produce desired populations of wildlife. Although generally overlooked, it can be a valuable tool for wildlife management. Other important factors, such as present land use and existing wildlife populations, require onsite investigation for their evaluation and are not a part of this guide. Soil interpretations should be used along with other types of information in a comprehensive study of wildlife.

Proper manipulation of soil, water, and plants to establish a suitable habitat is the most effective way to maintain and improve wildlife population. Knowing the properties of a named kind of soil makes it possible to predict how the soil will behave under various vegetative and water management practices. Thus, by using soil surveys, interpretations that are meaningful in wildlife management can be made.

Table 3 shows the suitability of the soils in the survey area for providing habitat. The combination of the ratings for the elements of kind of wildlife habitat approximates the suitability of a soil to produce that kind of habitat. The combination gives general habitat ratings that are not so meaningful or useful as the ratings for the specific habitat elements. For this reason the general ratings are presented only in combination with the suitability ratings for the applicable habitat elements.

Kinds of habitat

Openland habitat consists of cropland, pasture meadows, lawns, and areas overgrown with grasses, herbs, shrubs, and vines. Examples of openland wild

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By CLYDE A. SCOTT, biologist, Soil Conservation Service.

life are ring-necked pheasant, mourning dove, songbirds, and cottontail rabbit.

Woodland habitat consists of wooded areas of deciduous trees or coniferous trees and shrubs. Examples of woodland wildlife are blue grouse, ruffed grouse, woodpeckers, squirrels, mule deer, white-tailed deer, elk, and black bear.

Wetland habitat consists of swampy, marshy, or open-water areas. Examples of wetland wildlife are ducks, geese, shore birds, gulls, osprey, muskrat, and beaver.

Rangeland habitat consists of natural rangeland and woodland. Examples of rangeland wildlife are mule deer, white-tailed deer, coyote, snowshoe hare, and songbirds.

Habitat elements

Grain and seed crops are grain and other seed-producing annuals that provide food for wildlife. Examples are wheat, oats, barley, and clover seed.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that provide food and cover for wildlife. Examples are fescue, clover, and alfalfa.

Wild herbaceous plants are native or naturally established dryland grasses and forbs that provide food and cover for wildlife. Examples are pinegrass and tufted beargrass.

Coniferous plants are cone-bearing trees or shrubs that provide cover for wildlife or supply food in the form of browse, seeds, or fruitlike cones. Examples are Douglas-fir, ponderosa pine, gray fir, and western hemlock.

Shrubs produce buds, twigs, bark, or foliage used as food by wildlife or provide cover and shade for some wildlife species. Examples are snowberry, ocean spray, and snowbrush ceanothus.

Wetland plants are wild herbaceous plants of moist or wet sites, exclusive of submerged or floating aquatics, that produce food or cover for wildlife. Examples are bulrush and sedge.

Shallow water areas are areas where water is less than 5 feet deep. Examples are flood plain basins and depressions and beaver ponds.

The levels of suitability in table 3 are expressed as good, fair, poor, and very poor. *Good* means that habitat is easily improved, maintained, or created. There are few or no soil limitations in habitat management and satisfactory results can be expected. *Fair* means that habitat can be improved, maintained, or created on these soils, but moderate soil limitations affect habitat management or development. A moderate intensity of management and fairly frequent attention may be required to insure satisfactory results. *Poor* means that habitat can be improved, maintained, or created on these soils, but the soil limitations are severe. Habitat management may be difficult and expensive and require intensive effort. Results are questionable. *Very poor* means that under prevailing soil conditions, it is impractical to attempt to improve, maintain, or create habitat. Unsatisfactory results are probable.

The ratings in table 3 are determined by assigning weighted factors to the elements that make up the kind of wildlife habitat. For example, grain and seed crops, grasses and legumes, and wild herbaceous plants have greater weight than shrubs as habitat elements for openland wildlife.

Wildlife suitability groups

The soils of Boundary County Area have been assigned to eight wildlife suitability groups according to their potential for production of the four types of wildlife habitat. Each group is identified by a symbol.

The first figure in the symbol refers to openland habitat, the second to woodland habitat, the third to wetland habitat, and the fourth to rangeland habitat. Numerals 1, 2, 3, and 4 designate the quality of each kind of habitat. Number *1* means good, *2* fair, *3* poor, and *4* very poor. A dash means not suitable. For example, group 3241 is poor openland habitat, fair woodland habitat, very poor wetland habitat, and good rangeland habitat. Group 2-11 is fair openland habitat, unsuitable woodland habitat, good wetland habitat, and good rangeland habitat.

WILDLIFE SUITABILITY GROUP 1111

Ritz silt loam, 0 to 2 percent slopes, is the only soil in this group.

Soils in this group are good for openland, woodland, wetland, and rangeland wildlife. They are very deep, nearly level, poorly drained soils on low terraces along the flood plain of the Kootenai River. Most areas are artificially drained.

The average annual precipitation is 20 to 24 inches. Available water capacity is 11 to 13 inches. The mean annual air temperature is 45 to 47°F. The vegetation is mainly nonirrigated spring and winter wheat, oats, barley, pasture, and cloverseed. In some areas it is black cottonwood, thinleaf alder, redosier dogwood, pyramidal spirea, and tufted hairgrass.

The soils in this group provide habitat for mourning dove, ring-necked pheasant, songbirds, ducks, and geese.

WILDLIFE SUITABILITY GROUP 1131

The soils in this group are in the Farnhamton and Porthill series. They are good for openland, woodland, and rangeland wildlife and poor for wetland wildlife. They are deep, moderately well drained soils on high terraces and natural levees. Slopes range from 0 to 12 percent.

The average annual precipitation is 20 to 24 inches. Available water capacity is 11 to 13 inches. The mean annual air temperature is 43 to 47°F., and the frost-free period ranges from 115 to 140 days. The vegetation is mainly nonirrigated wheat, oats, barley, legume hay, and pasture. In some areas of the Porthill soil, the understory is Myrtle pachistima and associated plants and the overstory is western redcedar, grand fir, and western white pine. In some areas of the Farnhamton soil, the overstory is black cottonwood and the understory is redosier dogwood, pyramidal spirea, and tufted hairgrass.

The soils in this group provide habitat for deer, ruffed grouse, mourning dove, songbirds, squirrels, and coyote. They also provide nesting sites for waterfowl.

WILDLIFE SUITABILITY GROUP 2-11

The soils in this group are in the DeVoignes, Py-

well, Seelovers, and Schnoorson series. They are fair for openland and good for wetland and rangeland. They are not suitable for woodland. These are very deep mineral and organic soils in depressions on flood plains and stream bottoms. Slopes range from 0 to 2 percent.

The average annual precipitation is 20 to 30 inches. The mean annual air temperature is 43 to 49°F., and the frost-free period is 80 to 140 days. The water table fluctuates from the surface to a depth of 48 inches. The vegetation on the DeVoignes, Pywell, and Schnoorson soils, where protected, is mainly wheat, oats, barley, legume hay, and pasture. In unprotected areas, the native vegetation is black cottonwood, tufted hairgrass, willow, bulrush, sedge, thinleaf alder, mountain maple, pyramidal spirea, western hemlock, western redcedar, paper birch, Engelmann spruce, and some subalpine fir.

The soils in this group provide habitat for moose, ducks, and songbirds.

WILDLIFE SUITABILITY GROUP 2141

The soils in this group are in the Rubson, Selle, and Stien series. They are fair for openland, good for woodland and rangeland (woodland grazing), and very poor for wetland. They are very deep, well drained soils on glacial lacustrine terrace slopes and sandy terraces. Slopes range from 0 to 12 percent.

The average annual precipitation is 23 to 30 inches. Mean annual air temperature is 41 to 47°F., and the frost-free period ranges from 90 to 1.10 days. Nonirrigated crop areas produce small grain, legume hay, and pasture. There is a wide range in woodland habitat types where the overstory is Douglas-fir, western larch, western white pine, western hemlock, lodgepole pine, grand fir, and western redcedar. The understory is pinegrass, Myrtle pachistima, twin flower, ninebark, ocean spray, snowberry, mountain maple, and thinleaf alder.

The soils in this group provide habitat for mule deer, white-tailed deer, bear, elk, ruffed grouse, and squirrel.

WILDLIFE SUITABILITY GROUP 3141

The soils in this group are in the Artnoc, Caboose, Crash, Idamont, Kriest, Pend Oreille, Treble, and Wishbone series. They are poor for openland, good for woodland and rangeland (woodland grazing), and very poor for wetland. They are deep and very deep, well drained and moderately well drained soils on glaciated mountain slopes and glaciolacustrine terraces. Slopes range from 5 to 75 percent but are predominantly 45 to 75 percent.

The average annual precipitation is 20 to 40 inches. The mean annual air temperature is 40 to 49°F., and the frost-free period ranges from 70 to 140 days. The native vegetation is widely variable woodland. The overstory is mainly western hemlock, western redcedar, western larch, lodgepole pine, grand fir, western white pine, Douglas-fir, and ponderosa pine. The understory is Myrtle pachistima, twin flower, ocean spray, ninebark, pinegrass, snowberry, mountain maple, thinleaf alder, and other related forbs and grasses.

The soils in this group provide habitat for mule deer, white-tailed deer, bear, elk, songbird, squirrel, blue grouse, Franklins' grouse, and ruffed grouse.

WILDLIFE SUITABILITY GROUP 3242

The soils in this group are in the Elmira series. They are poor for openland, fair for woodland and rangeland (woodland grazing), and very poor for wetland. They are very deep, excessively drained soils on sandy terraces. Slopes are 0 to 20 percent.

The average annual precipitation is 23 to 28 inches. Available water capacity is about 3.5 to 5 inches. The mean annual air temperature is about 43 to 47°F., and the frost-free period ranges from 110 to 140 days. The overstory is Douglas-fir, ponderosa pine, and lodgepole pine. The understory is pinegrass, Myrtle pachistima, twin flower, kinnikinick, snowbrush ceanothus, ninebark, snowberry, ocean spray, and other related forbs and grasses.

The soils in this group provide habitat for deer, white-tailed deer, bear, and ruffed grouse.

WILDLIFE SUITABILITY GROUP 3343

Bane loamy fine sand is the only soil in this group. It is poor for openland, woodland, and rangeland (woodland grazing) and very poor for wetland.

It is on alluvial fans on the west side of the Kootenai River flood plain. Slopes are 2 to 8 percent.

The average annual precipitation is about 20 to 25 inches. The mean annual air temperature is 44 to 46°F., and the frost-free period is 90 to 110 days. The native woodland is mostly black cottonwood and scattered Douglas-fir and ponderosa pine. The understory is ninebark, snowberry, pinegrass, ocean spray, redosier dogwood, willow, and other related shrubs.

This soil provides habitat for mule deer, whitetailed deer, and bear.

WILDLIFE SUITABILITY GROUP 4444

Rock outcrop is the only land type in this group. It is very poor for all four kinds of wildlife habitat. It consists of nearly barren bedrock that has a mantle of less than 4 inches of soil material in places. Slopes range from 0 to more than 100 percent.

The average annual precipitation is 20 to 30 inches. The mean annual air temperature is 40 to 49°F., and frost-free period ranges from 70 to 140 days. The native vegetation is widely variable but includes scattered shrubs, forbs, and grasses. Tree species are on the intermingled Kriest, Treble, and Pend Oreille soils.

This area supports very little wildlife, but species common to the surrounding lands traverse this area. The larger areas along the Kootenai River provide nesting places for eagles and falcon.

Recreation

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 4 the soils of the Boundary County Area are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, and either access to public sewer lines or capacity of

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

the soil to absorb septic tank effluent. Soils subject to flooding are limited in varying degree for recreational use by the duration of flooding and the season when it occurs. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreation facilities.

In table 4 the limitations of soils are rated as slight, moderate, or severe (8). *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, or by a combination of these measures.

Information in table 4 can be supplemented by additional data in other parts of this manuscript. Especially helpful are interpretations for septic tank absorption fields, given in table 5, and interpretations for dwellings without basements and. for local roads and streets, given in table 6.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp area; are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface is free of stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of leveling a site.

Picnic areas are subject to heavy foot traffic, but most vehicular traffic is confined to access roads. The best soils for use as picnic areas are firm when wet but not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping and leveling sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If leveling is required to obtain a uniform grade, the depth of the soil over rock should be sufficient to allow necessary grading.

The design and layout of paths and trails for walking or horseback riding should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and not subject to flooding more than once during the period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners, community decision makers and planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in tables in this section are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by the soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within 5 or 6 feet of the surface, soil wetness characteristics, depth to a seasonal water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

Based on the information assembled about soil properties, ranges of values may be estimated for erodibility, permeability, risk of corrosion, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values may be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to-(1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for landuse planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented far soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations and testing.

The information is presented mainly in tables. Table 6 shows, for each kind of soil, ratings of the degree and kind of limitations for building site development; table 5 for sanitary facilities; and table 8, for water management. Table 7 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have different meanings in soil science and in engineering; the Glossary defines many of these terms.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that deal with the ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 5 shows the degree and kind of limitations of each soil for these uses and for use of the soil as daily cover for landfills.

If the degree of soil limitation is indicated by the rating *slight,* soils are favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel

WAYNE L. ROBISON, area engineering, Soil Conservation Service helped prepare this section.

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or fractured bedrock at a depth less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and as a result ground water supplies in the area may be contaminated.

Percolation tests should be performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity.

In many of the soils that have moderate or severe limitations for septic tank absorption fields, it may be possible to install special systems that lower the seasonal water table or to increase the size of the absorption field so that satisfactory performance is achieved.

Sewage lagoons are shallow ponds constructed to hold sewage while bacteria decompose the solid and liquid wastes. Lagoons have a nearly level flow area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. They generally are designed so that depth of the sewage is 2 to 5 feet. Impervious soil at least 4 feet thick for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in organic matter and those that have stones and boulders are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill refers to a method of disposing of solid waste, either in excavated trenches or on the sur-

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face of the soil. The waste is spread, compacted in layers and covered with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this purpose. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bed rock and a seasonal water table, are free of large stones and boulders, and are not subject to flooding. In areas where the seasonal water table is high, water seeps into the trenches and causes problems in excavating and filling the trenches. Also, seepage into the refuse increases the risk of pollution of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability than; might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 5 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

Daily cover for sanitary landfills should be soil that is easy to excavate and spread over the compacted fill during both wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for

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final cover of landfills should be suitable for growing plants. In comparison with other horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect: reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 6. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily over come. *A moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. *A severe* limitation indicates one or more soil properties or site features so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, and open ditches. Such digging or trenching is influenced by the soil wetness of a seasonal high water table, the texture and consistence of soils, the tendency of soils to cave in or slough, and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very

firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and small commercial buildings referred to in table 6 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation do not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and the large stones in or on the soil are also important considerations in the choice of sites for these structures and were: considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 6 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The AASHTO and Unified classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones, all of which affect stability and ease of excavation, were also considered.

Construction materials

The suitability of each soil as a source of road fill, sand, gravel, and topsoil is indicated in table 7 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed and described as the survey is made, generally about 6 feet.

Road fill is soil material used in embankments for roads. The ratings reflect the ease of excavating and working the material and the expected performance of the material after it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about soil properties that determine such performance is given in the descriptions of soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within the profile. The estimated engineering properties in table 9 provide more specific information about the nature of each horizon that can help determine its suitability for road fill.

According to the Unified soil classification system, soils rated *good* have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as high shrink-swell potential, high potential frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor,* regardless of the quality of the suitable material.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 9.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones, are low in content of gravel and other coarse fragments, and have gentle slopes. They are low in soluble salts, which can limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils, very firm clayey soils, soils with suitable layers less than 8 inches thick, soils having large amounts of gravel, stones or soluble salt, steep soils, and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is much preferred for topsoil because of its organic-matter content. This horizon is designated as Al or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 8 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water-control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have low seepage potential, which is determined by the permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and is of favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

An aquifer-fed excavated pond is a body of water created by excavating a pit or dugout into a groundwater aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 8 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability, texture, structure, depth to claypan or other layers that influence rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and allow the water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity of slope and steepness, depth to bedrock or other unfavorable material, permeability, ease of establishing vegetation, and resistance to water erosion, soil blowing, soil slipping, and piping.

Soil Properties

Extensive data about soil properties collected during the soil survey are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of samples selected from representative soil profiles in the field.

When he makes soil borings during field mapping, the soil scientist can identify several important soil properties. He notes the seasonal soil moisture condition, or the presence of free water and its depth in the profile. For each horizon, he notes the thickness of the soil and its color; the texture, or the amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or natural pattern of cracks and pores in the undisturbed soil; and the consistence of soil in place under the existing soil moisture conditions. He records the root depth of existing plants, determines soil pH or reaction, and identifies any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to characterize key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many of the soil series are available from nearby areas.

Based on summaries of available field and laboratory data, and listed in tables in this section, are estimated ranges in engineering properties and classifications and in physical and chemical properties for each major horizon of each soil in the survey area. Also, pertinent soil and water features are presented.

Engineering Properties

Table 9 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. Depth to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and in properties of each horizon is given for each soil series under the heading "Descriptions of the Soils."

Texture is described in table 9 in standard terms used by the United States Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms used by USDA are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (USCS) (2) and the American Association of State Highway and Transportation Officials Soil Classification System (AASHTO) (1). In table 9 soils in the survey area are classified according to both systems.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, and liquid limit. Soils are grouped into 5 classes-eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between

two classes have a dual classification symbol, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified as one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7. are fine-grained soils. Highly organic soils are classified as A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A--7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or more for the poorest. The estimated classification, without group index numbers, is given in table 9. Also in table 9 the percentage, by weight, of cobbles or the rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined largely by observing volume percentage in the field and then converting it, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four standard sieves is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistency of soil. These indexes are used in both the Unified and the AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior.

Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

All estimates given in table 9 have been rounded to the nearest 5 percent. Thus, when the ranges of gradation and Atterberg limits extend a marginal' amount across classification boundaries (1 or 2 percentage points), the classification in the marginal zone has been omitted.

Physical and Chemical Properties

Table 10 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the representative profile of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field-particularly soil structure, porosity, and gradation or texture-that influence the downward movement of water in the soil. The estimates are for water movement in a vertical direction when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and design of drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops and ornamental or other plants to be grown, in evaluating soil amendments for fertility and stabilization, and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is largely affected by the quality of the irrigation water and the irrigation practices. Hence, the salinity of individual fields can differ greatly from the value given in table 10. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others it was estimated on the basis of the kind of clay and on measurements of similar soils. Size of imposed loadings and the magnitude of changes in soil moisture content are also important factors that influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. *A high* shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion, as used in table 10, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rating of soils for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely within one kind of soil or within one soil horizon.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to

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soil blowing if cultivated. The groups are used to predict the susceptibility to soil blowing and the amount of soil lost as a result of blowing.

Soil and Water Features

Features that relate to runoff or infiltration of water, to flooding, to grading and excavation, and to frost action of each soil are indicated in table 11. This information is helpful in planning land uses and engineering projects that are likely to be affected by the amount of runoff from watersheds, by flooding and a seasonal high water table, by the presence of bedrock in the upper 5 or 6 feet of the soil, or by frost action.

Hydrologic groups are used to estimate runoff after rainfall. Soil properties that influence the minimum rate of infiltration into the bare soil after prolonged wetting are depth to a water table, water intake rate and permeability, and depth to layers of slowly or very slowly permeable soil.

Flooding is rated in general terms that describe the frequency, duration, and period of the year when

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flooding is most likely. The ratings are based on evidences in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about floodwater heights and the extent of flooding; and local knowledge that relates the unique landscape position of each soil to historic floods. Most soils in low positions on the landscape where flooding is likely to occur are classified as fluvents at the suborder level or as fluventic subgroups. See the section "Classification of the Soils."

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific; however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

A seasonal high water table is the highest level of a saturated zone more than 6 inches thick in soils for a

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continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed during the course of the soil survey. Indicated are the depth to the seasonal high water table; the kind of water table, whether perched or apparent; and the months of the year that the high water commonly is present. Only those saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at depths of 5 to 6 feet or less. For many soils, a limited range in depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and other observations during the soil mapping. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action is defined as freezing temperatures in the soil and movement of soil moisture into the freezing zone, which causes the formation of ice lenses. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Formation and Classification of the Soils

This section discusses the factors of soil formation and their effect on the soils of the Boundary County Area. In addition, it discusses the classification of the soils according to their morphology and genesis. Table 12 classifies the soils according to the classification system in current use.

Factors of Soil Formation

Soils are the result of five major soil-forming factors. These factors are the kinds or types of parent material from which the soil has been formed; the

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All tables have been updated and are available as a separate document.

organisms, both plant and animal, that have lived in and on the soil; the climate under which the soil has existed since accumulation of the parent material; the relief or lay of the land, which influences the climate of local areas and influences temperature and moisture content of the soils and their susceptibility to erosion; and the length of time that the soil-forming factors have been active. The factors of soil formation are so closely interrelated that few generalizations can be made regarding the effect of any one factor because the effect of each is modified by the other four. Many of the processes of soil development are unknown.

Parent material

The soils of the Boundary County Area formed in parent material of several kinds. The mountains are mostly of metasedimentary and granitic rock. These rocks have been glaciated leaving a mantle of glacial drift. The drift in many areas is covered by a thin deposit of volcanic ash and loess. The principal soils in the mountains are Treble, Kriest, Idamont, and Pend Oreille soils.

The high terraces adjacent to the broad Kootenai River flood plain near Naples, Paradise Valley, Highland flats, Kootenai orchards, and Curley Creek are primarily silty calcareous glaciolacustrine deposits many hundreds of feet thick. The Rubson and Porthill soils are on the gently sloping tops of the terraces. The Wishbone, Caboose, Artnoc, and Crash soils are on the terrace slopes. The Rubson soils are on the gentle toe slopes. Large areas of eolian sand associated with fast water deposition of the lake-laid sediments are near Naples, along the western edge of the North Bench, east of Moyie Springs, and adjacent to tie Kootenai River Canyon. The chief soils are of the Elmira and Selle series.

Pend Oreille soil is the principal soil on glacial drift on. mountain slopes near Round Prairie Creek and the Moyie River in the northeastern part of the survey area. Stien soil is the principal soil on glacial morainal materials on the valley side slopes. Chiefly Seelovers, Pywell, and DeVoignes soils are on stream bottom alluvial deposits.

Soils of the Kootenai River flood plain are forming in recent silty deposits. There are differences in drainage of the soils as a result of small differences in relief. The Farnhamton soil is on natural levees. The Ritz soil is on low terraces and ridges of the ridgeswale topography. The Schnoorson soil is in basins or in swales of the ridge-swale topography. The Pywell soil is in basins where thick deposits of organic matter have accumulated. DeVoignes soil is in basins where thinner layers of organic matter have accumulated.

Bane soil is the principal soil on alluvial fans at mouths of canyons on the west side of Kootenai River flood plain. Bane soil formed in fast water deposits of stratified sand, gravel, cobbles, and boulders.

Plants and animals

The kind and amount of vegetative cover has appreciably influenced soil formation within the survey area. High rainfall and consequent dense forest vegetation has produced soils that have organic surface horizons and thick A2 horizons that are low in organic matter. Decaying plant residues from conifers produce organic acids, which remove iron and aluminum as the acids move through the soil. This produces the pale brown bleached horizons just below the organic surface horizons in the Porthill soils and the lair horizon just below the organic surface horizons in the Rubson soils.

Soils that are influenced either by southerly exposures, steep slopes, or coarse textures are drier and have Al horizons and higher organic matter content. The Treble soil on coarse textured deposits has this kind of morphology.

In basins where soils are poorly drained, dense grasslike plants, shrubs, and trees produce thick accumulations of organic matter. The Pywell and DeVoignes soils formed under these conditions.

Rodents and other burrowing animals mix underlying material with the surface layer. This is most apparent in cultivated fields and in pastures where earthworms open channels and pores in the soil. Mixing the horizons and forming channels and pores aids aeration and water movement through the soil. The Seelovers soils have been mixed by earthworms.

Mixing of soil horizons by windthrow of trees is not prevalent on the mineral soils in the survey area, but does occur frequently enough to cause mixing of mineral soil material into organic soils, such as the Pywell and DeVoignes soils.

Climate

Climate is the most important factor in soil formation if it is given enough time to act on the soil material. Indirectly, it affects the kind and amount of vegetation and micro-organism activity, which in turn affects soil formation. Directly, climate affects weathering of rocks and minerals, redeposition of soil materials by wind and water, and movement of water through the soil. Climate not only varies on a broad geographic scale, but also differs greatly in a short distance because of slope, exposure, and elevation.

Prevailing winds are from the south-southwest in the Boundary County Area. Northerly winds are common in winter. This influences soil formation by affecting rainfall patterns, snow accumulation, redistribution of soil materials, and evaporation of soil moisture.

Two temperature zones used in the current system of soil classification (7) are recognized in this survey area. The warmer zone, where the average soil temperature is more than 47°F., is confined to the steep and very steep south-facing slopes of the glaciolacustrine terraces. The only soil in this warmer area is the Wishbone soil. The colder zone, where the average annual soil temperature is less than 47°, occurs in all other soils in the survey area. Within this colder zone, the Bane, Idamont, and Seelovers soils have mean summer soil temperatures of less than 59° if they lack an organic horizon and less than 47° if they have an organic horizon. The other soils have summer temperatures warmer than 59° and 47°.

The subhumid soils throughout the mountain and valley part of the survey area have a variation of rainfall from north to south and with elevation. Precipitation has very little effect on the soils of the Kootenai River flood plain. The mineral soils are usually calcareous to the surface layer as a result of the redistribution and deposition of calcareous soil materials by floodwater. The Farnhamton, Ritz, and Schnoorson soils are on the Kootenai River flood plain.

Relief greatly influences soil development and formation. Rainfall that is not absorbed tends to run off or to collect in depressions. On steep north-facing slopes, the sun's rays are less effective in heating the soil. Thus, vegetation is more dense, and the soil is cooler and more moist on north slopes than on south slopes. Evaporation is higher on south-facing slopes, and the soil is warmer and drier. Depressions or basins

are poorly drained and organic matter often accumulates.

The Kootenai River flood plain has a number of kinds of relief. It has some depressions, some nearly level low terraces, some gently sloping ridge-swale complexes on the inside of the river bends, and some gently sloping natural levees associated with the river and the perennial sidestreams. The most striking features of the flood plain are its gradient and its long meanders. The flood plain completely fills the valley north of Township 63 North.

Relief

Relief regulates the movement of water across or through the soil profile, thus regulating the particle size of sediment and the depth of leaching of salts and carbonates. The coarse-textured material in the stream load is deposited on natural levees nearest the channel and on the low terraces in the fast moving water. The finer textured materials are deposited in the basins or lagoons as the water velocity decreases or ponds.

One characteristic common to soils that have restricted drainage is the presence of gley horizons. Gleying is produced by alternating wetting and drying of the soil and results in the removal of iron and manganese from the horizon. The iron and manganese are oxidized and accumulate as reddish, yellowish, and brownish or blackish streaks, splotches, or concretions in adjacent horizons. Distinct or prominent mottling in the Ritz, Seelovers, and Schnoorson soils shows this condition.

The soils of the flood plain and stream bottoms are closely related to microrelief and drainage. The Farnhamton soils are associated with the moderately well drained natural levees, the Ritz soils with the poorly drained low terraces and the ridges in the ridgeswale complex, the Schnoorson soils with the poorly drained depressions and swales of the ridgeswale complex; and the DeVoignes, Pywell, and Seelover; soils with the very poorly drained and poorly drained basins or depressions where organic matter has accumulated.

The soils on the high glaciolacustrine terraces, terrace slopes, and glaciated mountain slopes are greatly influenced by aspect and water-holding capacity. The nearly level to moderately steep terrace tops have three major classes of soil material. The medium and moderately coarse textured materials of high water capacity are represented by the Porthill, Rubson, and Selle soils. The coarse textured soil material in dunes is represented by the Elmira soils. Aspect is the dominant soil characteristic associated with terrace slopes and glaciated mountain slopes. These soils are separated principally by microclimatic conditions. The resulting soil patterns are in the form of a hexagon and are very complex. The north-facing slopes are cooler and wetter and are represented by Pend Oreille and Crash soils.

The Treble and Wishbone soils are on the drier and warmer southwest-facing mountain slopes. Four soils partly formed in volcanic ash on mountain slopes. The Pend Oreille and Idamont soils are on north-facing slopes where the volcanic ash deposit is thicker. The Kriest and Treble soils are on the south-facing slopes where the volcanic ash deposit is thinner. The Artnoc and Crash soils are on north-facing slopes, and Caboose and Wishbone soils are on the south-facing slopes of terraces.

Time

Soil forming processes are usually slow, and an appreciable amount of time is required to change the parent material. The length of time necessary for significant changes to take place depends on the combination of soil-forming factors involved. Soils develop faster in a humid area than in a dry area. Soils on steep slopes develop more slowly than those on more level areas. More water runs off the soil surface, carrying soil material with it. This exposes parent material, which must be weathered before the soil can develop. Then less water percolates through the soil and is available for weathering and soil forming processes. Soils affected by periodic overflow on flood plains, stream bottoms, and alluvial fans are young because of repeated reworking and deposition of additional parent material. Heat and moisture promote chemical and biological activity in the soil; cold and dryness retard it. These and other factors affect the time required to alter the parent material.

The entire soil survey area was glaciated during late Wisconsin time. Volcanic ash has accumulated in areas protected from erosion during the major volcanic activity following the last glacial period. The most recent ash layer came from the eruption of Mt. St. Helens in the middle Cascades. This layer is easily observed in undisturbed soil areas outside the flood plains and bottoms.

Bane, Farnhamton, Ritz, and Schnoorson soils on the river flood plains, stream bottoms, and alluvial fans are the youngest soils of the survey area. In these soils, little or no leaching of carbonates has occurred.

Soils on the high glaciolacustrine terraces and terrace slopes are more leached than those on younger alluvium. Only the C horizons of these older soils have calcium carbonate. The Artnoc, Caboose, Crash, Rubson, and Wishbone soils have textural B horizons with clay films and clay bands.

Soils on the glaciated mountain slopes and glacial moraines do not have carbonate accumulations, but some soils do have subsoils with few thin clay films and wavy clay bands. Volcanic ash deposits are as thick as 30 inches in places. The surface layers are leached sufficiently to enhance color by iron oxidation. The volcanic deposit ash is too thin to influence classification in the Kriest and Treble soils, but is thicker and does influence the classification of the Idamont, Pend Oreille, and Stien soils.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and

apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (7). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available.

The current system of classification has six categories. Beginning with broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used at a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. In table 12, the soil series of the Boundary County Area are classified according to the system. Classes of the system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is identified by a word of three or four syllables ending in *sol* (Ent-i-sol).

SUBORDER. Each order is divided into suborders that are based primarily on those soil characteristics that produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. Each suborder is identified by a word of two syllables. The last syllable indicates the order. An example is *Aquent* (Aqu, meaning water or wet, and *ent,* from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with the growth of roots, the movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, the soil temperature, the major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the dark red and dark brown colors associated with basic rocks. Each great group is identified by a word of three or four syllables; a prefix is added to the name of the suborder. An example is Haplaquents *(Hapl,* meaning simple horizons, *aqu,* for wetness or water, and *ent,* from Entisols).

SUBGROUP. Each great group is divided into subgroups, one representing the central (typic) segment of the group, and others representing intergrades, which have properties of the group and also of one or more properties of another great group, suborder, or order. Subgroups also represent intergrades outside the range of any other great group, suborder, or order. Each subgroup is identified by the name of the great group preceded by one or more adjectives. An example is Typic Hapludults (a typical Hapludult).

FAMILY. Soil families are established within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when they are used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for properties, for example, texture and mineralogy, that are used as family differentiae (see table 12). An example is the coarse-silty, mixed (calcareous), frigid family of Aquic Xerofluvents.

Climate

The Boundary County Area is in the extreme northern part of the Panhandle division of Idaho. The elevation ranges from about 1,800 feet along the western side of the Kootenai River to about 4,400 feet in the southeastern part of the survey area. The moisture influence of the Pacific Ocean is felt in the Boundary County Area, particularly in winter in the form of an increase in average cloudiness, greater frequency of precipitation, and mean temperatures above those at the same latitude and elevation in midcontinent locations. This greater influence is partially caused by the great barriers to free airflow in central Idaho. The following paragraphs are based on data from Bonners Ferry, Idaho, unless stated otherwise.

The Boundary County Area is near the general path of fronts moving eastward from the Pacific Ocean and southward from Canada. This results in frequent changes in winter weather. Cold periods are frequent, but seldom last for any length of time. In the colder winter months the average daily maximum temperature is near, or slightly below freezing. Average daily minimum temperatures range from the high teens to the lower twenties. During many winters, minimum temperatures of zero or lower are never recorded, while in other years as many as 20 days of zero or lower are recorded. The coldest weather occurs when Arctic air from Canada enters the inland basin. Clear skies usually accompany these cold outbreaks and additional heat is lost by nighttime radiation. These cold outbreaks are often followed by a mixing of warm moist air from the Pacific and resulting cloudiness, fog, and some drizzle. Nighttime cloudiness reduces the loss of heat by radiation.

Minimum temperatures lower than -9°F occur about 2 years in 10. The area receives the greater portion of its annual precipitation of approximately 25 inches during the months of October through March. Less than 40 percent of the annual precipitation is received between April and September. Snowfall varies considerably as elevation varies and also from year to year. Seasonal snowfall may range from less than 10

See the unpublished working document "Selected Chapters from the Unedited Text of the Soil Taxonomy" available in the SCS State Office, Boise, Idaho.

National Climatic Center, Asheville, N.C.

inches to more than 90 inches. The average noon relative humidity at the Spokane International Airport, 93 miles southwest of Bonners Ferry, is about 65 percent. The prevailing wind is south-southwest at about 9 miles an hour.

Average daily maximum temperatures in spring range from the high forties to the high sixties. Average daily minimum temperatures range from the high twenties to the low forties. Little precipitation occurs in Bonners Ferry during the spring months. In late spring the runoff from melting snowpack at higher elevations provides water needed for irrigation, wildlife, recreation, and electrical energy in the Columbia River Basin.

Summers are warm, sunny, and generally dry. Average daily maximum temperatures range from the midseventies to the mid-eighties. Average daily minimum temperatures remain in the high forties. The average noon relative humidity at noon at the Spokane International Airport is about 25 percent. The prevailing wind is southwest at about 8 miles per hour.

During autumn average daily maximum temperatures range from the low forties to the low seventies. Average daily minimum temperatures range from the high twenties to the low forties. Precipitation amounts increase with the advance of the fall season. The average length of the growing season at Bonners Ferry is 129 days. The last spring freeze occurs about May 14 and the first fall freeze occurs about September 20.

Tables 13 and 14 give temperature, precipitation, and freeze dates for Bonners Ferry.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and ero sion control are extremely difficult.

Available water capacity (available moisture capacity). The

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All tables have been updated and are available as a separate document.

capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60inch profile or to a limiting layer is expressed as

	inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and then deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are

Loose.-Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard; little affected by moistening.

Cutbanks cave. Unstable walls of cuts made by carthmoving equipment. The soil sloughs easily.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.-Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope

gradients, as for example in "hillpeats" and "climatic moors."

Favorable. Favorable soil features for the specified use.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. None means that flooding is not probable; rare that it is unlikely but possible under unusual weather conditions; occasional that it occurs on an ave cage of once or less in 2 years; and frequent that it occurs on an average of more than once in 2 years. Duration is expressed as very brief if less than 2 days, brief if 2 to 7 days, and long if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting oil.' glacial ice. Many are interbedded or laminated.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

0 horizon.-An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.-The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.-A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a. soil lacks a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differs from that in the solum the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Low strength. Inadequate strength for supporting loads.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, common, and many; size-fine, medium, and coarse; and contrast-faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as

	pH		pH
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are-platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and *clay* particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.